

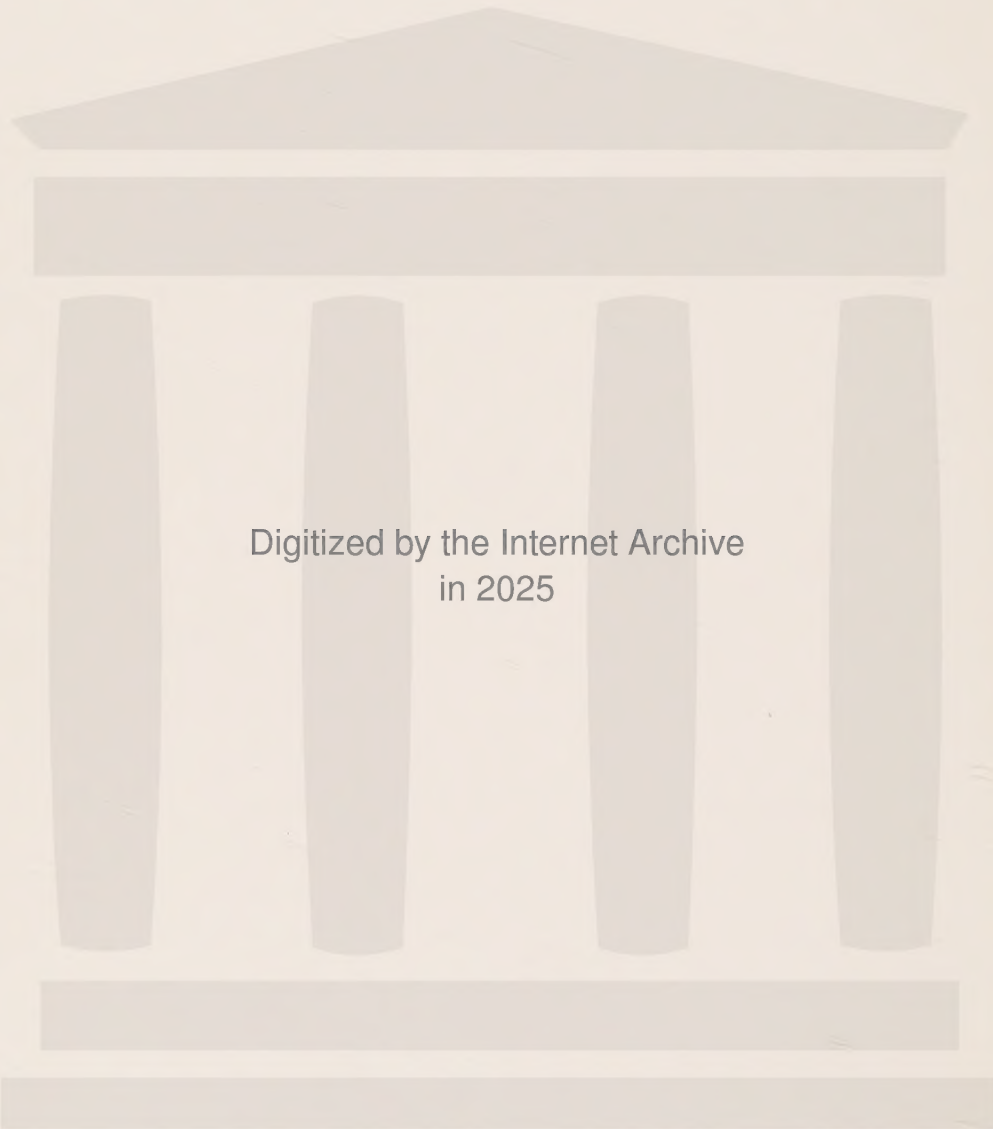


1955 *Report*

Experiment Station Committee

HAWAIIAN SUGAR PLANTERS' ASSOCIATION





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THE COMMITTEE IN CHARGE *of* THE EXPERIMENT STATION HAWAIIAN SUGAR PLANTERS' ASSOCIATION

REPORT

October 1, 1954 to September 30, 1955

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To the President and Members

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Gentlemen:

Research by the staff of your Experiment Station has been of vital importance in the operations of our industry. In submitting this Annual Report of the Director for 1955, it is your Committee's sincere belief that it is a progress report of much interest to the industry.

The keen interest of the Associate Members of the Experiment Station Committee and of the three Technical Advisory Committees, has been of great value to the Committee and to the Director, and we wish to express our appreciation to them.

It is appropriate that we here regretfully record the death in England of Dr. Robert C. L. Perkins on September 29, 1955. Dr. Perkins was the first to head the Entomology Department of the Experiment Station and contributed much to the successful control of cane leaf hopper in the early 1900's.

Respectfully submitted,

EXPERIMENT STATION COMMITTEE

F. W. BROADBENT, *Chairman*

J. D. BROWN
W. M. BUSH

R. A. COOKE, JR.
W. W. G. MOIR

Associate Members

J. W. ANDERSON
A. J. HEBERT
W. KENDA

D. E. LARSEN
D. J. MARTIN
W. M. MORAGNE

F. E. SIMPICH, JR.
A. WALKER
A. R. GRAMMER, *Secretary*

ADVISORY COMMITTEES OF THE STATION COMMITTEE

Agricultural Engineering

A. J. HEBERT,
Chairman
C. H. AHLF
J. D. BROWN
MALCOLM MACNAUGHTON
H. A. WALKER, JR.
L. S. McLANE
A. D. EDNIE
R. C. WILLIAMSON
KARL H. BERG
E. B. HOLROYDE
L. D. BAVER

Factory Engineering

W. KENDA,
Chairman
A. J. HEBERT
S. T. HOYT
F. A. SCHAEFER III
R. G. WATT
C. E. S. BURNS, JR.
J. S. BEATTY
PAUL R. TATE
R. T. WEBB
J. N. ORRICK
L. D. BAVER

By-Products

F. E. SIMPICH, JR.,
Chairman
A. J. HEBERT
W. KENDA
W. W. G. MOIR
F. A. SCHAEFER III
H. J. W. TAYLOR
M. J. BLACK
ALAN E. FAYE
F. C. CHURCHILL
R. JOHNSTON
L. D. BAVER

TO THE EXPERIMENT STATION COMMITTEE

Gentlemen:

It is with a great deal of satisfaction in terms of outstanding accomplishments that we submit to you the Annual Report of the Experiment Station for the year ending September 30, 1955.

The entire staff of the Station has worked diligently, long and efficiently in helping to solve the problems facing the industry. The results of their efforts are recorded within this report.

The Experiment Station was honored by having Dr. G. O. Burr, Principal Physiologist, serve as an advisor at the Geneva Conference on Peacetime Uses of Atomic Energy as a guest of the United States Government. This invitation reflects the pioneering work that Dr. Burr and the Station staff have been doing with radioisotopes as applied to agricultural research.

The technical aspects of the by-products research program were culminated in 1955, giving the HSPA and its cooperating partner, the Crown Zellerbach Corporation, top know-how in the making of pulp and paper from bagasse. The results of these researches will have important effects on the future diversification within the sugar industry. The cooperative research with Stanford Research Institute on the production of lightweight cement-bagasse flumes has proved that it is possible to make flumes with satisfactory strength that are about 60 per cent lighter than conventional flumes. Costs appear to be lower.

The cooperative research with the Imperial College of Tropical Agriculture has shown that Hawaiian filter cake contains many important organic chemicals that have industrial possibilities. Dr. H. Wayne Hilton was appointed to the staff as Principal Organic Chemist to pursue actively the organic chemistry research, to coordinate the activities in Honolulu with those of Dr. L. F. Wiggins in Trinidad, to act as liaison between the HSPA and the Sugar Research Foundation, and to establish and maintain contacts with industry on the mainland. Considerable interest has been exhibited already by leading chemical concerns in the organic chemicals we are finding in cane by-products.

Cooperative studies with Lihue Plantation Company have proved that a good system of preventive maintenance pays off in decreased breakdown and increased productivity of harvesting machines.

The Station research program has produced several procedures and equipment that have warranted patent protection. The patent on the corrosion inhibitor has been granted. Applications for patents have been filed for gamma ray weighing devices, the cross-flow cutter principle on cane harvesters, molded-rubber flume outlet, and the quick cooking of bagasse.

Dr. Walter Federer, Professor of Experimental Statistics from Cornell University, spent his sabbatical leave with the Experiment Station, during which time he assumed the responsibilities of the Head of the Department of Experimental Statistics. He contributed much to the research program of the Station.

Dr. R. P. Humbert, Principal Agronomist, was invited by the Colonial Sugar Refining Company to study their soils problems in Fiji. Dr. Humbert also discussed our cooperative cane disease trials with them.

F. A. Bianchi of the Department of Entomology spent six months in Madeira, Portugal, Azores and Canary Islands searching for natural enemies of the firebush. This was a cooperative project with the Territorial Board of Agriculture and Forestry.

W. A. Robinson, Senior Pulp and Paper Technologist, resigned in July 1955 to assume his new duties in charge of the operations of the Lockport plant of the Valentine Pulp and Paper Company in Louisiana, where he will continue his work in making paper from bagasse.

Miss Mabel Fraser, Librarian for 32 years, retired July 1, 1955. Her successor is Miss Charlotta Hoskins.

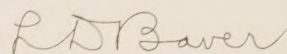
During the year, 793 volumes were added to the Library, of which 62 were gifts and 338 were returned from the bindery. There were 1805 books loaned, of which 282 were borrowed by other than staff members.

The Director spent three months on the mainland. About 60 per cent of this time was allotted to his long vacation. The other 40 per cent was occupied in (1) interviewing personnel for the Departments of Experimental Statistics, Sugar Technology, and Training of Personnel, (2) holding discussions with the staff of the by-products office in San Francisco, the Sugar Research Foundation in New York, and chemical concerns in the New York, Wilmington (Delaware), and Chicago areas on various phases of by-products research, and (3) conferring with Ionics Inc. in Boston on the cooperative project on the demineralization of sugar solutions.

All staff changes taking place during the year are listed on page 4.

Respectfully submitted,

EXPERIMENT STATION, HSPA



Director

STATION PERSONNEL CHANGES

October 1, 1954 to September 30, 1955

JOINED THE STAFF

G. F. B. APPEL
MELVIN J. CONJUGACION
Z. M. FREILANDS
J. GATIUAN
J. H. HEWETSON
H. WAYNE HILTON
CHARLOTTA M. HOSKINS
GEORGE G. KAY
ELDON D. LYON
O. R. MOE
TOSHIO MORITSUGU
R. E. MOTT-SMITH
ROBERT NAKAMURA
JAY A. SASAN
M. YAMAMOTO

Assistant-in-Training
Drafting Assistant
Assistant-in-Training
Machinist
Assistant-in-Training
Principal Organic Chemist
Associate Librarian
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Associate Technician
Assistant-in-Training
Laboratory Technician
Assistant-in-Training
Agronomy Assistant

TRAINING PERSONNEL
EXPERIMENTAL STATISTICS
TRAINING PERSONNEL
AGRICULTURAL ENGINEERING
TRAINING PERSONNEL
ORGANIC CHEMICAL RESEARCH
LIBRARY
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
SUGAR TECHNOLOGY
TRAINING PERSONNEL
PHYSIOLOGY & BIOCHEMISTRY
TRAINING PERSONNEL
AGRONOMY

LEFT THE STAFF

R. T. F. AEA
K. LYMAN BOND
W. K. BRAND
D. M. BURNS
MYRON CAPLIN
DANIEL DERESCHUK
A. W. DUVEL, JR.
WALTER T. FEDERER
ROBERT E. FREEMAN
ROBERT P. GAGNER
JOHN C. HANCE
GEORGE G. KAY
F. M. H. KIM
DENNIS K. P. LEE
GEORGE MURPHY
W. A. ROBINSON
HERBERT L. RUBIN
M. K. THOMPSON
F. E. TROTTER
R. T. VORFELD

Assistant-in-Training
Assistant Island Representative
Assistant-in-Training
Associate Agricultural Engineer
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Principal Statistician
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Agronomy Assistant
Drafting Assistant
Assistant-in-Training
Sr. Pulp & Paper Technologist
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training

TRAINING PERSONNEL
HAWAII SUBSTATION
TRAINING PERSONNEL
AGRICULTURAL ENGINEERING
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
EXPERIMENTAL STATISTICS
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
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AGRONOMY
EXPERIMENTAL STATISTICS
TRAINING PERSONNEL
BY-PRODUCTS
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL

RETIRED

MABEL FRASER

Senior Librarian

LIBRARY

ON LEAVE OF ABSENCE FOR MILITARY DUTY

JAMES A. RUSSELL

Assistant-in-Training

TRAINING PERSONNEL

BY-PRODUCTS

GOOD CORRUGATING MEDIUM MADE FROM BAGASSE

Cooperative researches with the Crown Zellerbach Development Laboratory have shown that bagasse corrugating mediums produced by semi-chemical pulping methods from depithed bagasse

fiber give good machine runnability and operate well on the corrugator. The quality of the corrugating medium is generally equal to or above that of normal commercial board.

NEUTRAL SULFITE PRODUCES GOOD PULP FROM BAGASSE

Pulping experiments at the Crown Zellerbach Development Laboratory have indicated that the neutral sulfite semi-chemical process produces a

satisfactory pulp for use in corrugating medium. The chemical requirements depend upon the type of bagasse being cooked and the base used.

PAPER TOWELS FROM HAWAIIAN BAGASSE

Depithed Hawaiian bagasse can be made into paper toweling that possesses very good absorbency, softness, color, and wet and dry strength,

on the basis of results obtained through cooperative research at the Crown Zellerbach Development Laboratory.

STORING BAGASSE HAS LITTLE EFFECT ON PULP QUALITY

Cooperative investigations at the Crown Zellerbach Development Laboratory have shown that, if molding and rotting are prevented, bagasse that

is stored up to seven months does not deteriorate sufficiently to produce significantly lower grades of pulp.

RIETZ DEPITHING GIVES SUPERIOR PRODUCTS

Pulping experiments at the Crown Zellerbach Development Laboratory have shown that bagasse

depithed by the Rietz process is superior to that depithed by the Rotex or Gruendler processes.

HIGH-GRADE WAX IN CANE WASH WATER

Preliminary experiments have indicated that a very high-grade wax is knocked off the cane stalks in the cleaning plant.

This wax has a high melting point and appears to have characteristics that are far superior to wax found in filter cake.

FILTER CAKE CONTAINS MANY ORGANIC CHEMICALS

Cooperative researches with the Imperial College of Tropical Agriculture have shown that many important organic chemicals are present in Hawaiian filter cake. These include fatty acids, com-

plex ceryl alcohols, and sterols. A rather intense interest has been exhibited by top-ranking chemical concerns in the industrial possibilities of these organic chemicals.

CEMENT-BAGASSE FLUMES FOR IRRIGATION

Cooperative experiments with the Stanford Research Institute have resulted in the development of cement-bagasse flumes of satisfactory quality and cost. Flume strength appears adequate even though the weight has been reduced by 60 per cent

compared to conventional concrete. Cost estimates indicate that a saving of 10 cents per lineal foot can be achieved along with the 60 per cent weight reduction. Two flume sections have been under study at Waialua since early 1955.

CULTURAL PRACTICES

AQUA AMMONIA HOLDS SPOTLIGHT IN FERTILIZATION RESEARCH

The first bulk shipment of aqua ammonia arrived in Hawaii in December 1953. In 1954, one-half of the nitrogen fertilizers purchased was supplied as aqua ammonia. This year it is expected that an even larger percentage will be supplied as aqua. This rapid shift to the liquid fertilizer has presented problems, many of which remain to be answered.

Applications by injection equipment have progressed slowly due to limited engineering assistance. Many problems had to be handled before the jump could be made from the small tractor equipment used on the mainland to the presently-used equipment shown in Figures 1, 2 and 3. Applications by injection equipment are proving most satisfactory. Equipment now being built on many plantations emphasizes the soundness of this method of application of liquid fertilizers.

Applications of aqua ammonia in irrigation water (Figures 4 and 5) are presenting problems which may require a modification of its use. Intensive studies to date have revealed the following facts:

1. Profile distribution studies show that aqua ammonia applied in irrigation water is held near the surface of the soil. In some soils, the entire application is contained in the top three inches, with the bulk of the nitrogen in the surface inch.

2. A single test with ammonium sulfate on soil of pH 7.2 revealed complete retention of the nitrogen from this carrier in the top three inches of soil.

3. For 35 tests on 200-foot furrows, the nitrogen content of ammoniated irrigation water decreased an average of 21 per cent between the head and tail of the lines.

4. Corresponding decreases were much smaller for other nitrogen carriers. For these carriers, decreases diminished in the following order: ammo-

nium sulfate, urea and sodium nitrate.

5. Ammonia concentration at any point down the furrow does not fluctuate in the various periods of flow during an irrigation.

6. Nitrogen losses of the order of four per cent were observed when ammoniated irrigation water flowed down 200-foot furrows lined with a plastic material to prevent contact with the soil. The decrease, which is attributed to volatilization, accounts in part for the observed decrease of nitrogen in the water in unlined furrows.

7. Intentional muddying of ammoniated irrigation water substantially decreased the nitrogen content of the water. This is used as evidence that part of the observed decrease in the nitrogen content of the water results from sorption of the nitrogen by the soil. This decrease, unlike that resulting from volatilization, does not constitute a loss of nitrogen to the field, but prevents a good application of fertilizer even with a good distribution of water.

8. Preliminary laboratory studies under controlled conditions indicate that, upon drying, substantial amounts of nitrogen may be lost from neutral and alkaline soils which had been treated with aqua ammonia and ammonium sulfate. The loss from aqua ammonia was always greater than that from ammonium sulfate.

9. Flushing the furrows with high inflow rates and high nitrogen concentration failed to improve the distribution of nitrogen over that obtained with a normal irrigation.

10. Applications of aqua in irrigation water to wet soils failed to improve the distribution of nitrogen over that obtained with a normal irrigation.

11. There was no significant difference in decrease of ammonia concentration down the furrow when aqua was applied to areas that had been previously fertilized.



Figure 1. Aqua ammonia is applied by injection equipment on unirrigated fields at Kohala. The aqua is applied through ground-driven positive displacement pumps mounted on a D-6 tractor. A clutch-operated transfer pump, driven by the rear power take-off, is used to fill the two 75-gallon truck tanks.

Figure 2. Aqua ammonia and solid fertilizers are applied at ratooning in irrigated fields at Waialua. The liquid and solid fertilizers are applied on both sides of two cane rows and the rate of application is geared to the speed of the tractor. This machine normally covers five to six acres per eight-hour day.

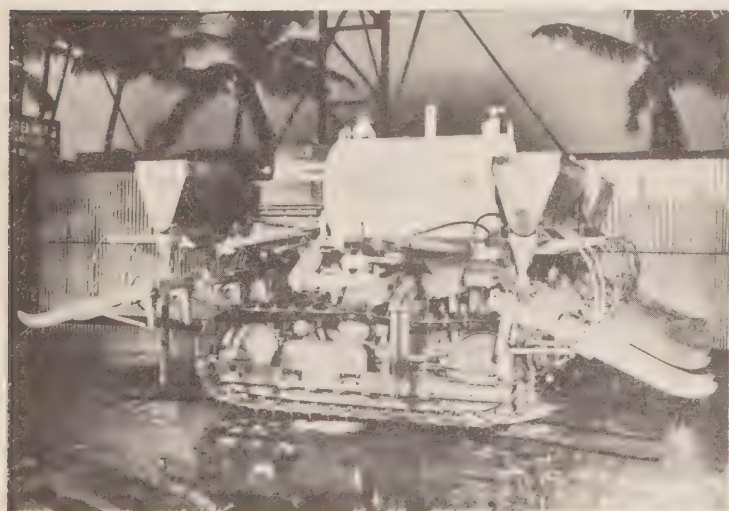
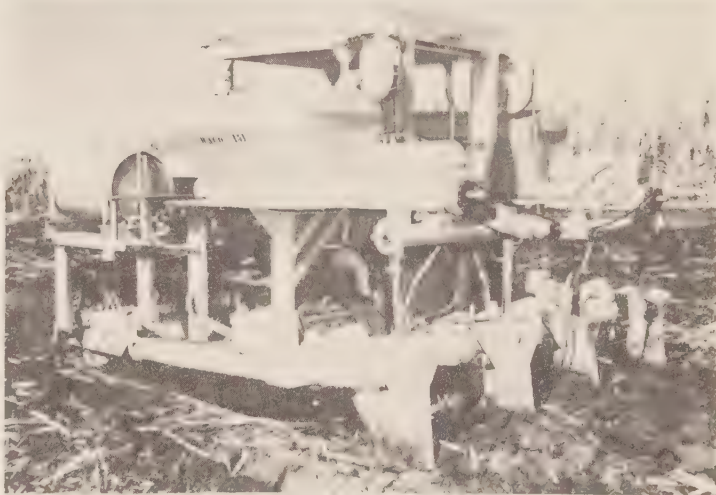


Figure 3. Onomea's new four-row, two-way fertilizer machine with full hydraulic control which applies aqua ammonia on both sides of each cane row from two 200-gallon tanks. Four stainless steel hoppers, each holding 500 pounds muriate of potash, deliver the potash to the surface of each cane line.



Figure 4. Aqua ammonia field tanks designed for handling and distribution to the fields by a materials carrier at Ewa.

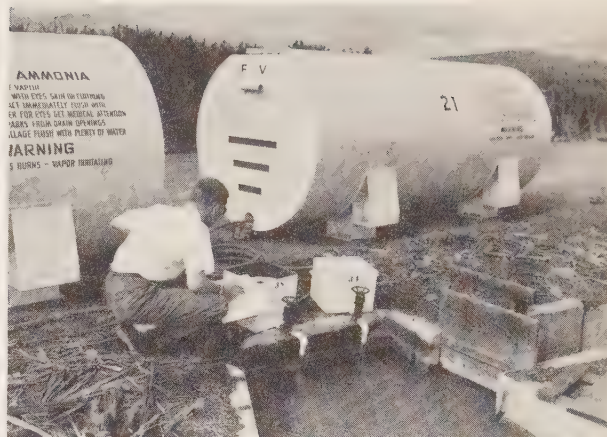


Figure 5. Aqua ammonia is applied in irrigation water at Ewa. Flow from the field tank to distribution ditch is controlled automatically.

TOURNAHAULER COMPACTION STUDIED IN DETAIL

Compaction tests with the larger cane hauling units were studied in detail at Waialua Agricultural Company, Ltd. Loaded tournatwo traffic usually exerts a ground pressure of 70 to 85 pounds per square inch to the soil surface. One pass can cause enough surface compaction to delay growth of the stools traversed. The delay in growth was shown to be due to soil compaction and not to physical damage of the cane stools. Degree of compaction and depth of compaction are increased by each additional pass in decreasing in-

crements until the increase becomes negligible. Under dry soil conditions, a depth of five to six inches of compacted soil results from heavy traffic. With operations in wet soils, the volume weight is increased to a depth in excess of 20 inches.

Root growth studies in artificially compacted soil blocks are enabling determinations of soil densities critical to sugar cane. Field operations causing critical compaction must be modified or costly reclamation will be required to ensure reasonably satisfactory yields.

CULTIVATION RECONDITIONS LIGHTLY COMPACTED SOILS

Close cultivation near the cane lines in infield roadways where traffic is light to medium heavy is being considered to reduce the areas which require plowing and planting. As much as 20 per cent

of the area harvested receives some degree of compaction. Test areas with different degrees of compaction have been scheduled for harvest to determine to what extent yield is affected.

SEEDBED PREPARATION NORMALLY ADEQUATE

Plantation tillage meets minimum requirements for cane growth in most fields. Fields harvested during dry weather and tilled during dry weather are usually adequately prepared. Those fields harvested during the rainy season and tilled under moist conditions do not produce optimum yields of cane and sugar. The compacted and puddled areas are not properly reconditioned and yields drop. As much as 20 per cent of the areas often

show significant decreases in rate of cane growth.

Tillage of infield roadways in ratooned fields is often inadequate. The depth and degree of granulation resulting from operations of different types of equipment on compacted infield roadways are under study at Waialua (Figure 6). Harvest results of these tests should indicate the degree of reconditioning required for optimum yields of cane and sugar.

Figure 6. A compacted roadway is reconditioned by a single pass of Ateco rock ripper at Waialua. The depth of ripping was 24 inches, but shattering between tines was negligible. This operation conditions the roadway so that subsequent passes of tillage implements prepare a reasonably satisfactory seedbed.



SOIL RESERVES IN CANE NUTRITION

Data from Grade A field experiments have been used to define the critical levels of available nutrients in the soil. Approximately 4000 soil samples were analyzed to assist in establishing the fertilizer requirements of plantation fields.

Phosphorus. The critical level of modified Truog P still stands at 20 p.p.m. for the low volume weight soils and is now set at 12 p.p.m. for the high volume weight soils. A high order of agreement exists between soil phosphorus and 8–10 stalk phosphorus, two entirely different approaches to the problem of determining the phosphorus needs of sugar cane.

Potassium. Studies of soil potassium levels in field tests indicate the preferential use of exchangeable potassium by the cane plant. Where the initial level of exchangeable potassium was high, the supply of K in this form was greatly diminished even by a single crop. Where the initial level of exchangeable K was low, there was restricted cane growth and, in general, only a slight reduction in exchangeable K, with most of the potassium used up by the crop being taken from the reserves

of non-exchangeable potassium in the soil.

Potash fertilization on the cane lines resulted in a raised level of exchangeable potassium in the interrow at the end of the crop. The effect is greater with each increment of potash fertilization. This is explained by a release of potassium by the roots in the interrow or the satisfaction of the plants' requirements by fertilizer potash applied on the lines, leaving the potassium changing from non-exchangeable reserves to exchangeable potassium to accumulate in the interrow.

Calcium. Harvest results of additional field experiments have continued to indicate that the critical level of exchangeable soil calcium is in the vicinity of 100 p.p.m. Correlation of tissue levels with yield data are under study.

Magnesium. Thousands of acres of highly leached soils of the Hilo and Hamakua Coasts and windward Kauai contain very small amounts of exchangeable magnesium. Field tests have been installed which will permit the determination of critical levels of magnesium in the soil and in plant tissues.

FIELD SAMPLES NOW UNDERGOING ANALYSES FOR TRACE ELEMENT DEFICIENCIES

The nutrient studies of 1954 established tentative critical levels or base sufficiency levels for the various parts of the cane plant for varieties 32–8560, 37–1933, 38–2915 and 44–3098. In 1955, 209 samples were analyzed by spectrographic tech-

niques for boron, phosphorus, magnesium, manganese, molybdenum, iron, aluminum, calcium, copper and zinc. By comparing normal and sub-normal cane samples, guides for future treatments are being obtained.

CROP LOGGING TECHNIQUES UNDER CRITICAL REVIEW

Comprehensive studies in the evaluation of crop log procedures have continued. The crop-logging data at Waialua have been analyzed and published.

Analyses from the extensive American Factors Coordinated Test have now been completed for both spring and fall plant crops, and will be finished for the ratoons within a few months. Analysis of the data is progressing satisfactorily. It is still too early to draw final conclusions. However, the recent statistical analyses support the data presented in the nutrition seminar last fall. Stalk analyses show higher sensitivity and greater reliability than foliar analyses for N and K.

Since all studies have shown highly significant analytical responses in the 8-10 internodes to added fertilizer phosphorus, an extensive study was undertaken to find the levels which were critically related to yield. Samples from 23 replicated field experiments on 10 plantations were analyzed for total phosphorus. The results are summarized in Table 1. Since the current crop had not yet been harvested, the yields from the preceding crops are compared with the analytical levels. A very sharp break occurs at .031 per cent phosphorus which is in agreement with the level which was set last year as critical for this element.

Table 1
Levels of Phosphorus in Internodes 8-10, % Dry Weight
Summary of 23 replicated field experiments (26 studies) on 10 plantations and 2 islands

Total P in internodes 8-10		Plant Response
0.020	0.031.....	Positive yield responses in TSA had been obtained on the previous crop of the experiment (11 studies). One study of plant cane.
0.032	0.064.....	No significant differences in TSA in previous crop of the experiment (9 studies). One study of plant cane. Adding P to soil may increase P in plant but this will probably be luxury consumption. At the lower range, phosphorus may be applied as insurance.
0.065-0.125.....		Adding P to soil had no significant effect on total P in internodes 8-10 (4 studies).

ANALYTICAL METHODS IMPROVED

Considerable work has been done by the Department of Chemistry in revising analytical methods employed in crop log analyses of cane leaf blade and leaf sheath specimens and in adapting them for use in determinations of nitrogen, total sugars, phosphorus, and potassium in stalk samples.

In this connection, a standard method for the determination of reducing sugars in cane stalk samples has recently been revised and adapted so that plantation personnel who are interested can

carry on this work in their own laboratories.

Modifications have been made in the procedures for determining ammoniacal, urea, and nitrate nitrogen in water specimens collected in connection with the Agronomy Department's investigation of nitrogen distribution by irrigation water.

Studies are under way at present on procedures for determination of calcium and magnesium in cane plant material and soil samples, using the Beckman spectrophotometer.

NITROGEN FERTILIZATION AFFECTS PLANT PHOSPHORUS

The strong depressing effect of nitrogen on stalk phosphorus, consistently observed in the Amfac test, shows striking regularity in the Makiki nu-

trition plots. The data shown in Figure 7 are from the nitrogen experiment which was terminated early because of fire in the field.

EARLY NITROGEN GIVES RAPID GROWTH

Two other interesting studies came from the early growth of the Makiki nitrogen plots destroyed by fire. These plots received from zero to 400 pounds of nitrogen per acre within the first three

months—either a single application 15 days after ratooning, or half then and half three months later. The old crop was ratooned on July 1, and the following months were hot and sunny. Stalks were

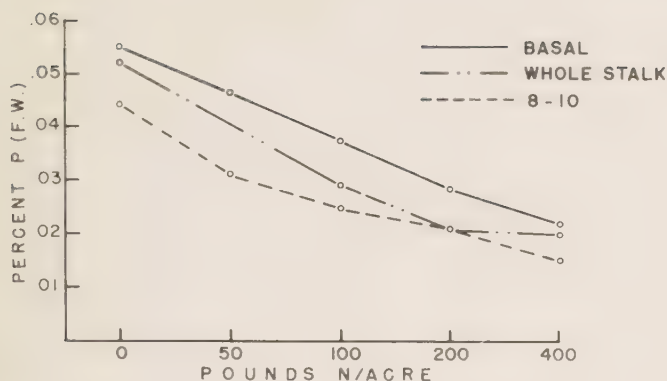
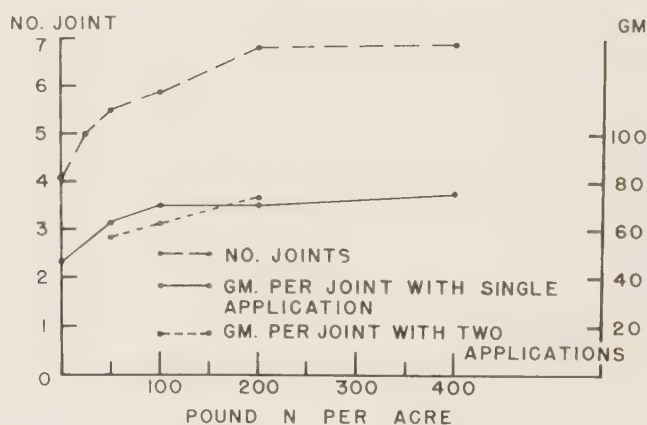


Figure 7. Depressing effect of fertilizer N on stalk phosphorus as graphically presented.

Figure 8. The effect of varying nitrogen fertilization on weight and number of elongated joints found in the first three months of growth.



tagged for the Physiology and Biochemistry Department's method of growth measurement. Some of the results are shown in Figure 8. It may be concluded that to get maximum number and size of joints in individual stalks, 200 pounds of nitro-

gen should be applied to the ratoons during the first three months. Photographs of the field confirmed this observation. These amounts of nitrogen are needed to give ratoons their best possible start in the hot summer months.

LEAF COLOR AND NITROGEN CONTENT CLOSELY CORRELATED

As a part of a continuing study of the relation of color to leaf composition, the chlorophyll content of the leaves was run by extraction with acetone followed by colorimetric estimation. In Figure 9 the relative levels of nitrogen and chlorophyll are plotted. The maximum is given by 200

pounds nitrogen per acre. Identical values were found for the 400-pound plots. When plotted as percentage of the maximum, a very good parallelism is found. The absolute range of leaf punch nitrogen through which this parallelism occurs is from 1.5 to 2.07 per cent.

8-10 STALK ANALYSES SHOW PROMISE AS GUIDES IN HARVEST SCHEDULES

The basic studies of the Department of Physiology and Biochemistry indicate that moisture, sucrose and reducing sugars of the 8-10 joints show promise in evaluation of cane maturity.

Analyses of preharvest samples at The Lihue Plantation Company, Ltd. confirm that 8-10 stalk tissues are possible guides to crop maturity and field yields. Low yielding fields in general are

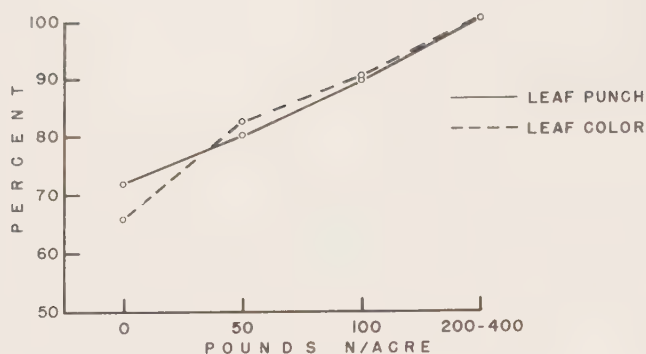


Figure 9. Leaf punch and color comparison is here expressed as per cent of maximum. (200-400 pound level). Cane was six months of age.

showing high N/K ratios in the 8-10 stalk with high reducing sugars and low sucrose. The purity is low and the tons cane per ton sugar is high. High yielding fields show low N/K ratios in the

8-10 stalk with low reducing sugars and high sucrose. The purity is high and the tons cane per ton sugar ratio is low. Extremely high levels of K in the stalk result in poorer sugar recovery.

CALIBRATION AND PATTERN STUDIES EVALUATE AERIAL FERTILIZATION

Cooperative studies were continued with several plantation and agency personnel, Island Representatives and Murrayair, Limited, to check the calibration settings and patterns of distribution of duster planes used for fertilizing sugar cane. Three basic-type duster planes were checked in this study:

Stearman biplane with conventional wings and a six-slot distributor.

Stearman biplane with conventional wings and a seven-slot distributor.

Stearman biplane with "high lift" wings and six-slot distributor.

Conclusions that appear logical from these tests are as follows:

1. Although appearing uniform on the ground, the fertilizer distribution by airplane, when accurately measured, is found to be too variable for small plot fertilizer tests. The accuracy is no greater in plots of several swaths than in single swaths. In most cases, only traces of fertilizer fell outside of 12-line plots when wind velocity was below five miles per hour.

2. At a given intensity of wind, the distribution pattern is more satisfactory when the fertilizer is released at 40 feet above ground than at 25 feet or less. At higher altitudes there is too much drift, particularly of the fine fraction in the mix.

3. Both the "high lift" wing and the seven-slot distributor showed improvement in pattern when tested independently of the other. The combination remains to be tested.

4. The reason for occasional streaking is not entirely evident from the studies. There were no cases of areas receiving no fertilizer. It was found, however, that when the agitator in the base of the supply tank in the plane was kept running during travel or take-off and approach to the field, some packing occurred. This interfered with proper flow of the fertilizer through the throat of the distributor. On days of high humidity, this condition might be more severe than on days with relatively low humidity. This could readily account for differential fertilization to the extent of causing uneven applications which result in streaking.

5. Dusting of fertilizer is not advisable when wind velocities exceed 12 to 15 miles per hour.

6. Even though the air application pattern is not considered satisfactory for fertilizing test plots, it is still considered satisfactory for field-scale second-season fertilization. Studies are continuing to improve the techniques of application.

Murrayair, Limited, has continued research and development of their planes in an attempt to provide efficient service to the plantations. One

Figure 10. The wing of the "high lift" Stearman duster plane shown above has an increased lifting capacity over the conventional type of wing, making possible a greater payload or slower flying speed, or both. The "spoilers" at the ends of the wings decrease the slippage of air from below to above the wing tip which occurs with the conventional-type wings, and thereby tend to eliminate vortex action which carries the smaller particles up with the air.



such development has been the installation of "high lift" wings on their Stearman airplanes. This type of wing provides greater lifting capacity or slower flying speed, or a combination of both as needed (Figure 10).

Another development has been the installation of a seven-slot fertilizer distributor on the duster

planes. This distributor is constructed according to the latest recommendations from the Personal Aircraft Research Center at Texas A & M College at College Station, Texas. This research center has carried out extensive studies in application of dry fertilizers, seed, and liquid sprays of pesticides by aircraft.

FOLIAGE DESICCATION STUDIES SHOW PROMISE ON HAWAII

Cooperative studies have been conducted with Olaa Sugar Company, Ltd. and Hilo Sugar Plantation Company in the use of chemicals for rapid drying or killing of sugar cane foliage to facilitate burning the leaves and tassels prior to harvest. The following chemicals have been included in tests applied by ground rig at Olaa:

Magnesium chlorate.

Dinitro compounds in water and oil.

Oil and water-soluble forms of pentachlorophenol and its sodium salt.

Aromatic and diesel oils only.

Nitrogen fertilizer solution.

Ocean water.

Two different proprietary compounds of magnesium chlorate have been applied by spray plane at both of the above plantations.

Juice analyses taken at three-day intervals after spraying showed that no apparent deterioration of the juice had taken place by the twelfth day. The most satisfactory desiccation was from magnesium chlorate, dinitro, and pentachlorophenol solutions. Further studies into effect of chemicals on ripening are in progress.

STUDY OF MOISTURE TENSION CHARACTERISTICS OF PRINCIPAL SOIL TYPES CONTINUING

Five new moisture tension chambers were assembled and placed in operation to expedite the characterization of the principal irrigated soils.

These moisture tension curves are serving as the basis for intelligent irrigation management regardless of methods of irrigation control.

STUDIES SHOW BETTER IRRIGATIONS WITH LOWER GRADES OF LINES

Two slope-rate-of-flow tests were installed in 1954, one at Waialua and the other at Hawaiian Commercial & Sugar Co., Ltd. The studies up to

eight months of age have shown better irrigations were obtained in the lower grades of line. At Waialua, a 10 gpm increase or decrease in the

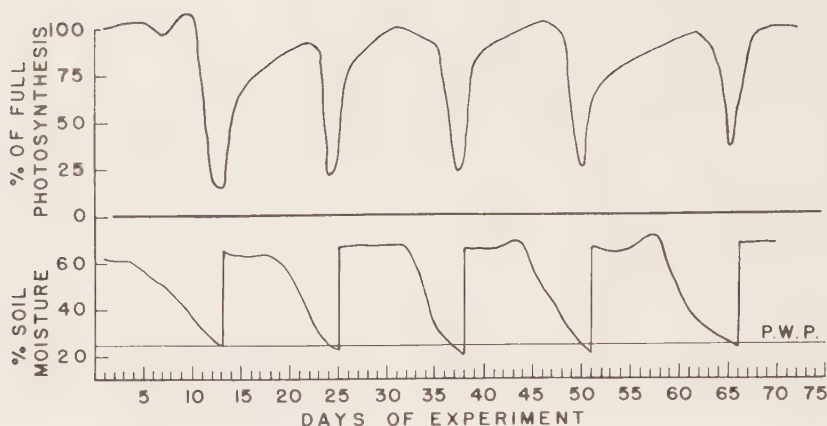


Figure 11. This graph shows the effects on photosynthesis of a series of cycles of alternating low and high soil moistures. A single irrigation was used to bring the soil back to maximum capacity after drying to wilting point.

furrow inflow rate had a more pronounced influence upon the water distribution than a one per cent change in grade. At HC & S, a change in slope from 2.5 per cent to 0.5 per cent produced a 30 per cent increase in infiltration capacity,

whereas a change in rate of flow from 18 to 25 gpm produced a 20 per cent increase in furrow water uptake capacity. These tests are being continued to study the possible limitations of lower grades of line in older cane.

SMALLER QUANTITIES OF WATER REQUIRED FOR SUGAR CANE

An irrigation experiment was set up at Waialua to compare the effects on sugar cane yields of treatments of two, four and six acre inches of water applied during irrigation. Water was applied whenever two-thirds of the available soil moisture had been depleted in the zone of maximum root concentration.

Irrigation Treatment	No. of Rounds	Yield Data			
		TCA	Q.R.	Y% C	TSA
2 acre in.	27	117.8	7.6	13.2	15.5
4 " "	25	122.2	7.8	12.9	15.6
6 " "	24	115.9	7.6	13.1	15.2
LSD		ns	..	ns	ns

There were no differences in yields with the three

irrigation treatments. Two inches of water applied at any one irrigation are adequate as long as good distribution can be obtained. A good distribution was possible in this experimental layout with 60- to 80-foot lines. These data emphasize the fact that in many presently-used systems of irrigation, water is being wasted in order to satisfy the minimum water requirements at weak points along the lines. It is of interest to note that 54 inches of irrigation water, applied when needed in small increments, produced as much TCA and TSA as 144 inches of water applied in six acre-inch increments.

EXPERIMENT SHOWS RELATIONSHIP BETWEEN SOIL MOISTURE AND PHOTOSYNTHESIS

Using the photosynthesis chambers, pictured on page 18 in the 1954 Annual Report, and the infra-red spectrophotometer for measuring carbon dioxide, as many as five complete cycles of drying and irrigating were run on several pairs of sugar cane plants. The soil moisture was followed with

radioactive Co 60, which permits measurement with any desired frequency without disturbing roots or soil.

Figure 11 illustrates an interesting relationship between the rate of photosynthesis and the drying out of the soil. The rate of photosynthesis does not

decrease at a uniform rate during the drying period. The cane plant maintains the original rate of photosynthesis until the soil moisture approaches the permanent wilting percentage. The first sharp break in the rate of photosynthesis of 37-1933 grown in pots of Manoa soil occurred when the soil moisture was about four per cent above the permanent wilting percentage.

RADIOACTIVE COBALT AND RUBIDIUM AID IN RESEARCH STUDIES

The Co 60 method of measuring soil moisture is being applied to several studies. The permanent installation at Wahiawa is showing promise of giving excellent results. The soil moisture was also successfully measured during the Physiology and Biochemistry Department's experiment on ripening of sugar cane by drying off. In the pot studies

The recovery of the original rate of photosynthesis after irrigation was slow, requiring several days. A recovery of 80 to 90 per cent of the original rate of photosynthesis was achieved in about two days. It is to be emphasized that these data are from potted plants and do not necessarily apply to field conditions. Future work is being planned for a similar type of field study.

of the relation of soil moisture to photosynthesis, the method proved to be entirely satisfactory. Large amounts of Rb 86 were used during the past year in tracing irrigation water, and future plans call for continued use of the element for this purpose. Its use as a tracer for potassium is being given further study.

MEASURING CANE TONNAGE AT HARVEST WITH COBALT 60

In June 1955, at the request of HC & S, the weight of standing cane ready for harvest was measured by radioactive cobalt. Two plots, each measuring 14 feet by 30 feet (six lines) were chosen: Field 712 planted with 37-1933, Field 402 with 38-2915.

A pushrake opened up strips six lines wide, across which the measurements were taken. An arbitrary "zero" position was chosen, with the radioactive sources and receiver two inches above the top of the ridge on which the equipment was mounted. This is called "ground level" and is

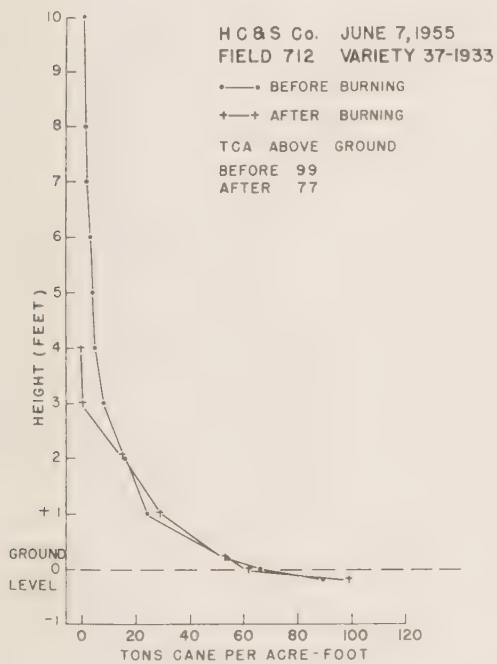


Figure 12. Standing cane weighed with Co 60.

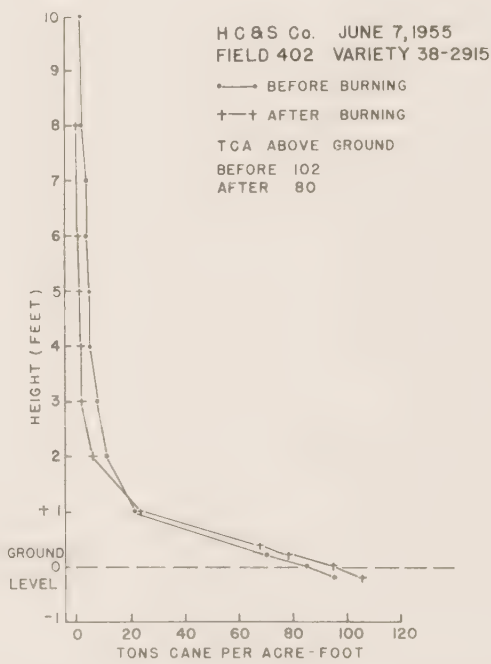


Figure 13. Standing cane weighed with Co 60.

plotted as 0 feet on the graphs. If all the lines were level with, or below, the lines carrying the equipment, there was no soil included in the 0 shot. Shots were then taken at minus two inches, plus two inches, plus four inches, plus one foot, and at one-foot increments thereafter. It is very likely that the minus two-inch shots included some soil in the weights.

After the equipment and the source of Co 60 were mounted, measurements were made on unburned cane. Then, with the equipment remaining rigidly fixed, the cane was burned and measured again. Under these conditions, the only factor changed by the burning was the weight and distribution of cane.

The results, shown in Figures 12 and 13, are calculated in tons cane per acre-foot, a unit of measurement which represents the weight in tons of a layer of cane, one foot thick and of uniform density, spread over one acre of land.

From the two graphs which summarize the results, the following conclusions can be drawn:

1. Approximately 20 tons of material disappear from above ground during burning. This is due partly to settling and partly to burning of trash, dead cane, etc. The settling effect is shown by the increased tonnage at the two-inch level in each case. The burn was much better in 37-1933 and no cane remained above the four-foot level.

2. The slope of the curve at ground level is such that the method promises little precision for weighing cane without cutting. A change of two inches at the ground level can alter the tonnage estimate by more than 10 per cent. The shape of the curve is very different from that of young upright cane shown on page 13 of the 1953 Annual Report.

3. The present study is useful for preliminary estimates of the amount of cane cut by knives set at different levels above the tops of the lines.

4. With some modifications, radioactive cobalt may have value for measuring cane in experimental plots, even at harvest time. This possibility is now being studied.

KILLING RATS WITH AIRPLANES

The high cost of labor and the great difficulty of distributing rat bait in inaccessible cane field edges and gulches has made research for another additional and cheaper method of rat control an urgent necessity.

Air distribution of poisoned pellets to kill rats in gulches and waste areas immediately adjacent to field edges has tremendous physiological appeal over the more laborious and slower but still reliable method of placing bait in long lines of spaced feeding stations.

Cooperative studies were initiated with Hilo Sugar in the manufacture and distribution of cereal-base pellets, each containing a lethal dose of thallium sulfate (Figure 14). Preliminary results have been sufficiently encouraging to warrant a full-scale treatment of some of the inaccessible rat harbors, surrounded by or adjacent to big cane. This method is not a substitute for our reliable feeding station method of control but will be used, as conditions warrant, as an additional tool in our never-ending battle against rat invasions from our waste borders.



Figure 14. First experimental lot of paraffin-dipped poisoned pellets for air distribution at Hilo Sugar. Attracted by raw linseed oil, rats found and ate these pellets better than was anticipated. Dead rats found along the field alanui were convincing evidence.

DISEASES

HAWAIIAN CANES TESTED IN FIJI FOR DISEASE RESISTANCE

The results of the 1955 varietal resistance trials conducted in Fiji in cooperation with the Colonial Sugar Company, Ltd., were satisfactory. Approximately 57 per cent of the Hawaiian varieties proved resistant or highly resistant to downy mildew and a higher incidence of Fiji disease was reported in the 1955 tests than in previous tests.

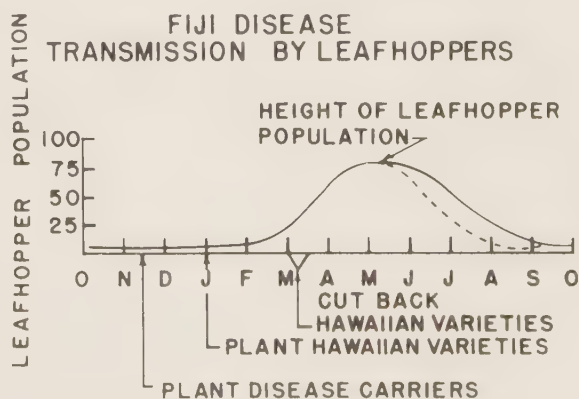
Fiji disease is transmitted by the leafhopper (*Perkinsiella viliensis*). In Fiji, the leafhopper population fluctuates considerably, normally beginning to increase around the first of February, reaching a peak during April and June, and then decreasing rapidly. A low population of hoppers results in a low degree of disease transmission. Therefore, a longer period is required for testing varieties against Fiji disease than against downy mildew. Planting of varieties to be tested against Fiji disease is timed so that when young plants are most susceptible, they will be exposed to the greatest numbers of leafhoppers (Figure 15).

The reactions of commercial varieties and seedling canes to downy mildew and Fiji disease are as follows:

Variety	% of Total Acreage in Hawaii	Reaction to	
		Downy Mildew	Fiji Disease*
37-1933.....	32.60	++	=+
44-3098.....	24.58	-	-
38-2915.....	17.71	=-	-
32-8560.....	5.81	++	-
32-1063.....	5.80	=+	-
39-7028.....	3.97	++	=
39-3633.....	3.07	+	+
38-4443.....	1.63	+	-
41-3340.....	.93	=	-
39-4753.....	.60	+	-
Total.....	96.70		
41-2772.....		++	*
45-2654.....		++	-
46-564.....		++	*
49-101.....		+	*
49-134.....		=-	*
49-3533.....		-	*
49-3637.....		-	*
50-723.....		=	*
50-2606.....		=-	*
50-5665.....		=-	*
51-4336.....		++	*

Symbols: + or ++ Resistant or highly resistant
 =+ Moderately resistant
 = Average resistance
 =- Moderately susceptible
 - or -- Susceptible or highly susceptible
 * Insufficient information for final grading.

Figure 15. In the Fiji disease resistance trials, the susceptible varieties (disease carriers) are planted in November and the Hawaiian varieties soon thereafter. Occasionally the latter are cut back so that the young plants are exposed to the maximum number of leafhoppers.



NEW CANE VARIETIES IN MOLOKAI QUARANTINE

In cooperation with other members of the Quarantine Committee, cuttings of 23 new cane varieties received from Washington, D. C., and Canal Point, Florida, on October 27, 1954, were

planted in the quarantine house. One variety failed to become established. Twenty-three varieties, having completed their two-year quarantine period, were released to the other islands.

THE CANE DISEASE PICTURE IN HAWAII

The inspection of plantations showed that specific diseases are important factors in causing lower sugar yields. The early adoption of disease control measures is necessary to prevent continued losses.

Red rot remains a serious problem in localized areas of 38-2915 on windward Kauai.

Chlorotic streak was found more widely distributed on several Oahu plantations than formerly; in one case, seed taken from cane affected with chlorotic streak and used for planting was partially responsible for the poor growth of cane in the field.

Leaf scald was less evident on 44-3098 in the Kapoho and Kamaili sections of Oloa than it was in 1954. However, it continues to be a threat to this variety under conditions of extreme drought.

Ratoon stunting disease has not been noted in any new commercial areas during the year, but it could cause economic losses if disease-free seed sources are not maintained.

The presence of 2,4-D in the hot-water treatment tank was found responsible for very poor germination in one instance. Several plant fields had to be replanted.

CHLOROTIC STREAK DISEASE TRANSMISSION STUDIES

Water culture studies were conducted to determine if chlorotic streak disease is transmitted from diseased to healthy plants through the roots. When grown with diseased plants, only one of 16 healthy plants of Trojan and none of four plants of 47-4991 exhibited symptoms of chlorotic streak during the plant crop.

Four months after the plants were ratooned, 10 of 20 originally healthy plants exhibited symptoms of chlorotic streak when growing in pots with diseased plants. In four pots, each containing four healthy plants, all the plants in one pot showed symptoms of chlorotic streak, while the plants in the other three pots remained healthy.

LEAF SCALD LESS SEVERE THAN IN 1954

As the result of more favorable growing conditions, the incidence of leaf scald on 44-3098 was considerably lower in the Kapoho, Kamaili and Oloa sections of Oloa than it had been in 1954. Infrequent cases of the disease were noted on a few other plantations on Hawaii.

Results from a leaf scald test installed at Kapoho, which included 26 commercial and promising varieties, showed that the following varieties were affected with the disease: 39-7028, 44-3098, 45-2708, 47-1914, 48-546, 49-118, and the susceptible checks: 28-4291, 39-3859, and 40-5168.

STEM GALLS IN RELATION TO RATOON STUNTING DISEASE

During 1954, it was reported that stem galls developed on the internodes of 39-3633 and 44-3098 under drought conditions, and that galls developed on 51-9037 when it was irrigated frequently. Later observations showed that 51-9037 was affected with ratoon stunting which may have caused a physiological drought by limiting water

uptake. In order to determine whether ratoon stunting may be a factor in gall development, a test was recently installed with ratoon stunting disease-inoculated cuttings and with disease-free cuttings of 32-8560, 39-3633, 39-7028, 44-3098, and 51-9037. The test will receive irrigation at different intervals.

SOURCE OF SEED AND PMA TREATMENT IMPORTANT IN GERMINATION AND PINEAPPLE DISEASE CONTROL

The importance of planting good seed to ensure a suitable stand cannot be overemphasized. Re-

planting with inferior seed is costly and results in weak growth. As previously recommended, a num-

ber of plantations have developed disease-free areas as seed sources. These areas should be located on the best soil, well-drained and adequately fertilized. The use of selected disease-free seed treated with phenyl mercuric acetate (PMA) increases germination, gives a better stand, and reduces losses from pineapple disease to a minimum.

The use by several plantations of the HSPA inhibitor in the hot PMA solution has shown that

this chemical reduces the amount of PMA required to maintain the proper concentration of PMA in the hot-water tanks and extends the interval during which the HPMA solution can be used before it is necessary to empty the tank and renew the solution.

Nine new fungicides were tested for their effectiveness against pineapple disease. None was found superior to PMA.

RATOON STUNTING DISEASE UNDERGOES INTENSIVE STUDY

Commercial Clorox gave better control of knife transmission of ratoon stunting disease than a 10 per cent Lysol solution, and is, therefore, recommended for swabbing cane knives to prevent the spread of this disease. At the end of the day, a knife swabbed with Clorox must be washed and dried, then covered with a protective film of vaseline or oil to prevent rusting. New chemicals are being screened in a search for one better suited for this purpose.

To obtain further information on various phases of ratoon stunting disease, field experiments were installed at Waipio Substation in cooperation with Waipio staff members, as follows: testing chemicals for the control of knife transmission of the disease; determining the resistance of species and varieties of sugar cane; studying the effect of fertilization on the severity of internal symptoms; investigating methods of inoculation; determining whether the infective principle can be transmitted

equally from the nodes and internodes of diseased stalks, and to what extent diseased juice can be diluted and still transmit the disease.

A test, with the varieties 32-8560, 37-1933, 38-2915, and 44-3098, and designed to measure sugar losses caused by ratoon stunting, was harvested at 26 months of age at Waipio. The results from the plant crop showed no significant losses for cane grown from cuttings inoculated with juice from canes affected with the disease. In Australia, losses from ratoon stunting in the plant crop are sometimes small, especially if water and fertilization were not limiting factors for growth. This test is being ratooned under subnormal irrigation conditions.

A second test, using diseased cuttings of 47-2060 and 47-4991 and designed to study the effectiveness of the long hot-water treatment (LHWT—50°C. for 2 hours) for controlling ratoon stunting, was harvested at the age of 25 months at Waipio.



Figure 16. Growth response from methyl bromide at the Pathology Plot. Rows 2 (32 8560) and 3 (37 1933) were fumigated before planting, while rows 1 (32 8560), 4 (37 -1933) and 5 (32-8560) were untreated.

Differences in sugar yields for cane grown from diseased and diseased-treated cuttings were not significant with 47-2060. However, with 47-4991, a marked increase in T_{SA} resulted by controlling

ratoon stunting with the LHWT. In Australia, it has been shown that some varieties are much more tolerant to ratoon stunting disease than others and this may be the case with 47-2060.

- 1964/5 sugar cane - control.

SOIL FUMIGATION BECOMES A MAJOR PROJECT

Definite growth responses from soil fumigation have been obtained in observational and/or Grade A tests with DD and EDB. On different plantations, varying amounts of these fumigants are applied as broadcast and row treatments as group test No. 26. The group test is designed to determine the amount and method of application of DD and EDB for increasing sugar yields in low-yielding areas.

Other promising soil fumigants, such as methyl

bromide (Figure 16) and 1-2, dibromo-3-chloropropane, are being screened for their effectiveness in increasing soil productivity.

The research on soil fumigation is being carried out in conjunction with the yield decline of varieties which appears to be caused mainly by biological factors, including nematodes, fungi, bacteria, soil insects, and viruses. These organisms are not uniformly distributed in all soils, which explains the degree of response from soil fumigation.

FACTORY

COMPARISON OF MILLING OF PUSHRAKE AND CUTTER-WINDROWER HARVESTED CANE AT LIHUE

As a part of a long-range program set up to determine the comparative economics of cutter-windrower and pushrake harvesting, 10 tests were conducted on the Lihue "B" mill.

In each test, cane from two four-acre plots, one of which had been pushraked and the other harvested by cutter, was milled and data were col-

lected on milling results, juice analysis, and calculated recovery.

The tests will have to be continued over several years to arrive at significant figures. The results for this year, however, indicate no large differences in the milling characteristics of or sugar recovery from cane harvested by the two methods.

TWO GAMMA RAY WEIGHING DEVICES OPERATED UNDER FACTORY CONDITIONS

Cooperative studies by the Departments of Physiology and Biochemistry and Sugar Technology are using gamma ray weighing devices, incorporating industrial-type measuring and recording instruments, which have been built and operated experimentally at the factories of Ewa Plantation Company and Waialua. The units, illustrated in Figure 17, differ from the laboratory type first set up in that they utilize the ionization

chamber principle rather than the Geiger counter.

The Ewa and Waialua weighers are both set up on raw sugar streams, but incorporate instruments of different manufacture, so that comparisons of performance may be made. The results obtained have proved that the gamma ray unit is a useful device. Development work must be continued in order to arrive at a stable and relatively trouble-free production instrument.

POLYELECTROLYTES OFFER SOLUTION TO SOME CLARIFICATION PROBLEMS

Polyelectrolytes are high molecular weight organic compounds developed commercially as flocculating agents. During the year, an investigation has been made on the value of these materials as clarification aids.

Laboratory and factory tests have demonstrated that certain polyelectrolytes are often very effective in increasing the settling rate and reducing the volume of settlings, as well as improving clarity. Their action, however, varies very widely with the type of juice. Particular effectiveness was found on juices from the Mahaulepu area of Grove Farm Company, Ltd., but limited success was obtained with juices from the Hilo area of Hawaii (Figure 18). The materials thus appear useful in the treatment of so-called refractory juices encountered from time to time and from cane from certain areas.

Although the cost of polyelectrolytes is relatively high, the amount required is in the range of only four to 10 parts per million, so that the treatment cost is reasonable. The range of costs normally would run between 10 cents and 35 cents per ton of sugar. This is small compared with the additional costs incurred by slowdowns due to clarification trouble. Investment cost of equipment necessary to apply the materials is low.

Permanent systems for use of polyelectrolytes have been made at Grove Farm and Kahuku Plantation Company factories. These systems are put into use whenever clarification trouble warrants. Experimental systems have also been set up by HC & S and Pioneer Mill Company, Ltd.

Work continues on the fundamental theory of polyelectrolyte action and on evaluation of new materials as they become available commercially.

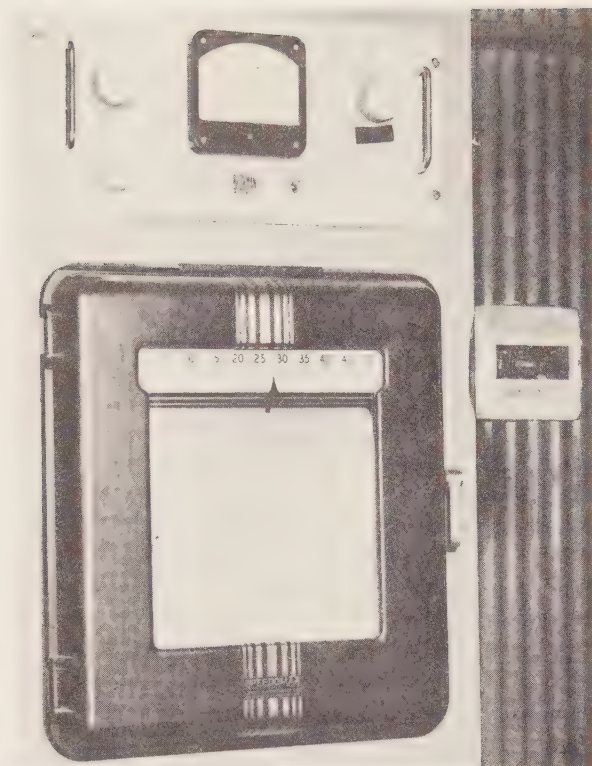
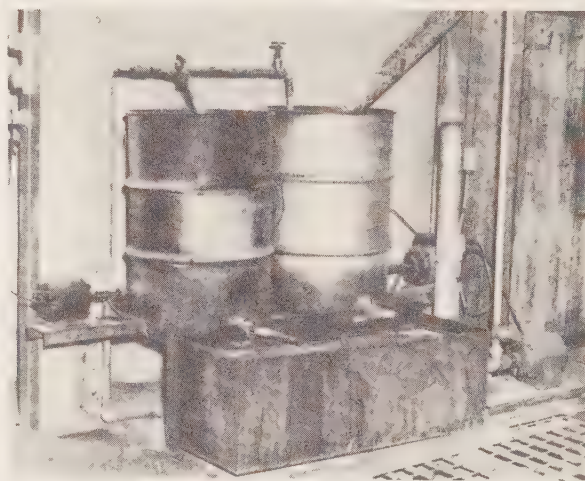


Figure 17. Preamplifier and recorder units used in gamma ray weighing of sugar at Ewa. Weight totalizer is mounted at right of recorder.

Figure 18. Equipment used at Grove Farm in preparing polyelectrolyte solutions.



SECONDARY CLARIFICATION OF FILTRATE INVESTIGATED AT WAIALUA

An experimental filtrate clarifier of new design was installed this year at Waialua by the Dorr-Oliver Company under a cooperative arrangement between the two companies and the Experiment Station, HSPA. The unit utilizes the flotation principle to separate juice from suspended matter and employs triple superphosphate as the clarification agent (Figure 19).

Experiments were made with the clarifier during the year and various modifications in design were tried. At times, very good results were obtained, but at other times, the unit would not handle the load and give satisfactory clarification. Dorr-Oliver engineers are now redesigning the clarifier in light of the results obtained. When suitable design is obtained, the clarifier will be evaluated.



Figure 19. Dorr-Oliver filtrate clarifier at Waialua.

ION EXCHANGE MEMBRANE DEMINERALIZER PILOT PLANT BUILT

A small pilot model demineralizer unit utilizing Ionics ion exchange membrane principle has been constructed by Ionics Inc. under a contract with HSPA. The apparatus will be installed at the Puunene factory of HC & S and will be tested during the coming year.

The demineralizer has a capacity of 250 to 500 gallons of juice per hour. Initial work will be conducted on syrup from the third cell of the evaporator station at a 30 per cent solids concentration. Demineralization in the range of 30 to 75 per cent will be studied.

SALT CRYSTALLIZATION IN LOW-GRADE MASSECUITES REMAINS A PROBLEM ON MAUI

The use of Hilo area molasses in low-grade sugar strikes, which has been of considerable help during the past two years in preventing the crystallization of potassium chloride, has been discontinued. This is due to the fact that the potassium content of the Hilo area molasses has risen to the point where the quantities necessary to affect boiling favorably

are at an impracticable level. New boiling techniques worked out by the staff of HC & S appear to be of help in boiling. In the meantime, efforts in the direction of ultimately solving the problem have been directed toward demineralization, and the Ionics technique appears to be the most promising procedure.

STUDIES OF RATE OF CRYSTALLIZATION OF SUGAR FROM MOLASSES BEGUN

New temperature-controlled apparatus has been set up for studying the effects of various constituents upon the rate of crystallization of sugar.

The apparatus enables the simultaneous study of several samples. The first constituent to be studied is potassium chloride.

INSECTS

THE GENERAL INSECT PICTURE IN HAWAII

With few exceptions, sugar cane insects continued under satisfactory biological control during the past year.

Two plantations suffered serious borer damage

following heavy rat damage. On another plantation, there was a short-lived outbreak of nutgrass armyworms which migrated into a cane field from nearby grass.

LONGER CROPPING POSES A SUGAR CANE BEETLE BORER PROBLEM

The trend toward longer cropping logically implies more damage by the sugar cane beetle borer (*Rhabdoscelus*) because the *Ceromasia* parasite of the borer is least effective in the last months before harvest. Borer damage inevitably increases following rat injury, and no single plantation operation so directly affects the borer situation as rat control. The beetles are attracted to souring rat-eaten stalks, and because rind hardness no longer deters them, their breeding is greatly accelerated. The primary step to forestall heavy borer losses, therefore, is effective rat control.

The harder the rind, the greater the borer grub mortality, a factor made good use of by the gene-

ticists. Tasseling is also a factor; canes are much softer after tasseling than before, and severe borer losses have followed heavy tasseling. Hard-rinded, light-tasseling varieties, some of them well suited to regional requirements, are available to replace the softer canes which are heavily attacked by borers.

Tests made in cooperation with the Chemistry and Genetics Departments suggests that rind hardness is correlated with lignin content; there was no correlation with silica content.

The parasite fly continues to maintain itself on all plantations. It is particularly effective against the borer during the first year of cane growth.

BLACK LIGHT ATTRACTS INSECTS TO TRAPS

In cooperation with the personnel at the Waipio Substation, a comparative study was made of the insects attracted to different types of light in the light traps. The merits of ultraviolet (black) light (GE B14, 100 watt) and of ordinary 100-watt white light were judged on the basis of total numbers caught, and of catches in certain insect groups which contain pests not yet established in Hawaii. The light traps were installed in two locations at Waipio, approximately 250 feet apart, on a bluff overlooking Pearl Harbor. The positions of the two traps were reversed halfway through each run to compensate for differences due to location.

From mid-March to May (37 nights at one

location, 36 at the other) catches in round numbers were:

	Position I	Position II	Total
Black light.....	63,000	28,000	91,000
White light.....	19,000	6,000	25,000
Total.....	82,000	34,000	116,000

The black light yielded over three times as many insects as the white light, regardless of position. Figure 20 shows the insects caught by the two types of light during 16 nights in August: approximately 40,000 by the black light, and 7000 by the white.

Also compared were captures taken from June first to August 24 (42 nights in each location) in

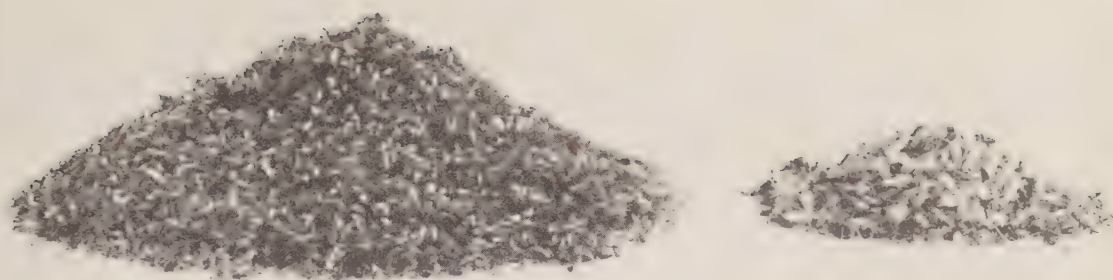


Figure 20. Two light traps were operated at Waipio for 16 nights in August, one with white light, the other with black light, both of equal wattage. Left: The ultra violet (black) light attracted approximately 40,000 insects, including many more small species than were attracted by the white light. Height of pile is about four inches. Right: The ordinary white light attracted approximately 7000 insects.

certain selected groups which include cane pests in other sugar regions of the world, as listed below.

These studies indicate that ultraviolet light of the type tested offers a better means than any used before for early detection of new insect im-

migrants. Black light will be the standard used from now on in the insect survey project.

During the year, another leafhopper new to the Islands was taken for the first time in the Ewa light trap. It is an American species which feeds on legumes, *Kunzeana kunzei* (Gillette).

	Black light	White light
Lepidoptera (Moths)		
Phalaenidae.....	79	13
Pyralidoidea.....	289	67
Geometridae.....	35	11
Tortricidae.....	68	63
Total.....	471	154
Coleoptera (Beetles)		
<i>Adoretus</i>	217	159
Other Scarabaeidae.....	587	128
Elateridae.....	257	43
Total.....	1061	330

	Black light	White light
Homoptera (Leafhopper)		
Fulgoridae		
<i>Perkinsiella</i>	159	29
<i>Peregrinus</i>	18	18
Others.....	6	0
Cicadellidae		
<i>Empoasca</i>	131	68
<i>Draeculacephala</i>	4	1
Others.....	180	25
Total.....	498	141

Grand Total Black light 2030; White light 625

ARMYWORMS DO NOT MARCH ON

In March, an outbreak of nutgrass armyworm (*Laphygma exempta*) occurred on Maui when young plant cane was damaged by caterpillars moving in from grassy areas. Parasitic flies and wasps accompanied them in great numbers and prevented development of a second generation. Locally, the recent immigrant armyworm, (*Spodoptera mauri-*

tia) is still restricted to Oahu and has not yet been found on sugar cane.

During the year, some 140,000 *Telenomus nawai*, a wasp which parasitizes several kinds of armyworm eggs, were reared in the laboratory for local distribution on Oahu. In addition, 10,000 were sent to Maui and Hawaii. *Telenomus* was supplied

at the request of the Maui County Agent, the Board of Agriculture and Forestry, the Trust Territory of the Pacific Islands (for release on Ponape), and the government of American Samoa.

Several hundred parasite flies (*Eucelatoria* and *Frontina*) were also sent to Samoa for use against armyworms where it is hoped *Eucelatoria* will also attack *Prodenia litura*.

SYSTEMIC INSECTICIDE USEFUL IN WATER CULTURE EXPERIMENTS

In glasshouse experiments, sugar cane grown in water cultures by the Department of Physiology and Biochemistry is sometimes so heavily infested by leaf mites, *Oligonychus indicus* (Hirst), and cane aphids as to invalidate experimental results. It was found that by adding to the nutrient solution an organic phosphate, octamethyl pyrophosphoramidate, the aphids were killed within a few days at most, and the mites after a somewhat longer time. A dilution of 1:6400 killed all mites in about two weeks; stronger dosages were effective

sooner. A dilution of 1:100 did not visibly injure the cane (37-1933). The effect of this treatment on the composition of the plants is being investigated. Earlier tests with octamethyl pyrophosphoramidate in water cultures and with cane growing in soil, failed to kill the sugar cane pink mealybug at strengths which injured the plants. It must be emphasized that octamethyl pyrophosphoramidate is an extremely dangerous material, and its use on sugar cane is restricted to closely controlled experiments.

MEALYBUGS UNDERGO SCRUTINY

A year ago, a comprehensive, continuing study of mealybugs in relation to sugar cane was begun. Some of the findings are: (1) an apparent low in mealybug population exists in the winter months, regardless of variety or location (windward vs. leeward Oahu); (2) varietal differences in infestation are sometimes very definite; (3) mealybugs can survive on unplanted cuttings for as long as six weeks; and (4) crawlers of both the pink and the gray mealybug are windborne in the field. The usual manner of spread is by planting material which has not received the hot water treatment.

As part of the mealybug project, the role of the Argentine ant in cane fields is being studied. Because this ant protects mealybugs against their natural enemies, a marked increase in mealybugs, particularly the gray mealybug, follows its establishment in cane. Wherever established, the Argen-

tine ant far outnumbers other ants commonly found in cane fields, and interferes more seriously with the beneficial insects attacking mealybugs than, for example, the *Pheidole* ant does.

Argentine ants largely disappear after a cane field is harvested, a few surviving mainly on volunteer plants where food from aphids and mealybugs is to be had. A few may survive precariously under trash for a time, with little or no food. Re-establishment of the ant in newly-planted fields does not occur immediately. In an irrigated field under observation, ants were found to have moved into the field margins from volunteer plants along the roadside about three months after the field was planted. They reached the middle of the field about a month later. An important factor which delays early reinvasion of newly-planted fields is the absence of shade during the early months.

HSPA AIDS IN SEARCH FOR FIREBUSH CONTROL INSECTS

In a cooperative agreement with the Hawaii Cattlemen's Association and the Board of Agriculture and Forestry, F. A. Bianchi made a six-month search in Portugal, the Azores, the Canary Islands and Madeira, for insect and other enemies of the fire tree (*Myrica faya*) for possible intro-

duction into Hawaii. This tree has become a pest on some ranches, and its control is desirable. Five shipments were sent from Madeira to Honolulu, including a seed weevil and a caterpillar which feeds on the flowers. These are being tested on other possible host plants prior to release.

INTERDEPARTMENTAL STUDIES

YIELD DECLINE INVESTIGATIONS

THE VARIETY-YIELD PICTURE IN HAWAII

Yield decline of sugar cane varieties is a problem of world-wide importance. Increased sugar yields have been achieved chiefly by replacing older varieties with newer varieties, particularly where fallowing and crop rotation have not been practiced. Experience has shown that sugar cane varieties are unable to maintain indefinitely the high yields which they produced when first planted.

In Hawaii, the sugar yields averaged slightly less than five tons per acre in 1913, while in 1954 the yield was 10.02 tons per acre (Figure 21).

During this period, the commercial varieties have been frequently replaced with newer ones. The more important factors contributing toward the increased sugar yields since 1913 are:

1. Superior varieties, possessing more vigor and disease resistance.
2. Improved cultural practices, including cultivation, time of planting, irrigation, fertilization, weed control, special soil amendments by the use of organic matter (bagasse and cane trash), and soil aeration through better drainage.

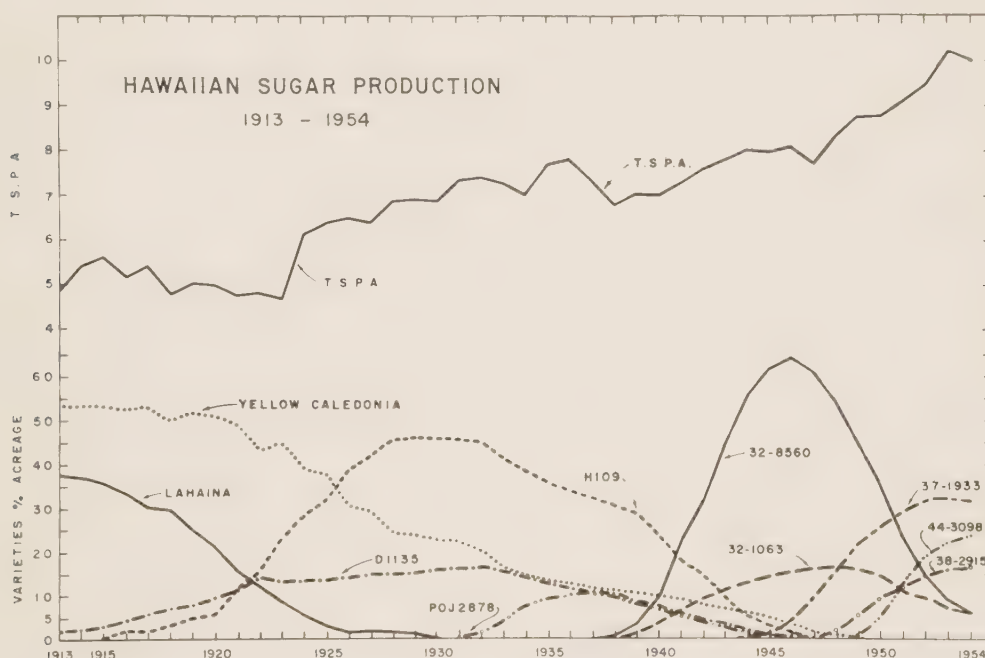


Figure 21. The average sugar yield per acre and the major commercial varieties in Hawaii from 1913 through 1954.

3. Disease and insect control.

Understanding the exact cause of yield decline of varieties presents a complex problem. Information here and elsewhere indicates that varietal yield decline of sugar cane, as of other agricultural crops, is caused mainly by biological factors, which may include nematodes, fungi, bacteria, soil insects, and viruses. These factors are not uniformly distributed in all areas. Plant pathogens attacking various plant parts have caused reduced yields. The development by mutation of new strains of fungi explains the loss of varietal resistance; this may also be the case with viruses.

FIELD EXPERIMENTS SHOW EXCITING RESPONSES

Two Grade A tests were installed in 1954, one with H 109 and 37-1933 at Oahu Sugar Company, Ltd., the other with 32-8560 and 44-3098 at Hamakua Mill Company. The treatments were: check vs. organic matter (30 TPA, dry basis) and/or soil fumigation (400 pounds DD (1,2-dichloropropane; 1,3-dichloropropene) and five pounds chlordane per acre). So that nutrition from N, P, and K will not be a limiting factor during the growth of the cane, nor be reflected in yields at harvest in 1956, fertilization is based on monthly foliar and stalk analyses; four applications of N,

Little evidence is available to explain yield decline on the basis of genetical changes in the variety. However, mutations within a variety do occur and may give rise to strains superior or inferior to the original clones.

The environmental factors, including climate and the physical and chemical composition of the soil, often affect plant growth. Low air and soil temperatures, inadequate soil aeration, soil compaction, soil erosion, lack of organic matter, low soil fertility, and either excess or insufficient soil moisture, have caused poor growth in specific areas.

P₂O₅ and K₂O have been applied to all plots, the totals per acre being:

	Date Planted	N	P ₂ O ₅	K ₂ O
Oahu Sugar.....	May 13, 1954	350	400	350
Hamakua Mill..	Aug. 19, 1954	324	390	484

A marked growth response has resulted from DD alone with 32-8560 and to a lesser extent with 44-3098; the effects are less marked with H 109 and 37-1933. In the absence of DD, compost appeared to have an early depressive effect upon growth; in the presence of DD, no such depression was observed.

POT STUDIES AIM AT FINDING "SICK" SOILS

Growth failure of 37-1933, and to a lesser extent of H 109, 32-8560 and 44-3098, was induced in pot studies when sterilized (steam) and untreated Makiki soil was inoculated with a small amount of soil from poor growth areas on Kauai, Oahu, and Hawaii.

Some of the "sick" soils, having been pinpointed, are being treated with fumigants, in an effort to control those biological factors which may be causing poor growth. The ultimate goal is to isolate or otherwise determine the specific factors causing depressed growth.

INSECTS AND NEMATODES ARE UNDER SUSPICION

In numerous observation tests, the insecticides DDT, chlordane, aldrin and dieldrin, in amounts of from two to five pounds per acre, all greatly reduced the amount of damage done to cane roots by Collembola and other soil inhabitants. In comparison with untreated plots, damage was reduced more than 85 per cent in 31 plots where furrow applications were made, but without improving growth. Therefore, the great stimulus so often obtained from DD, which is as effective as the insecticides in reducing root injury, cannot be credited to the killing of the insects in the soil.

Early in the year, studies of inoculated soils in pot cultures suggested that *Trichodorus* nematodes might be a factor in growth failure. Later work has not supported this view. In more recent studies, the types and numbers of parasitic nematodes occurring in Hawaiian soils suggest that they may be partly responsible for subnormal growth in specific areas.

Nematode extractions are made from a wide range of soils and are sent to Mr. Max J. Fielding, Nematologist, United States Department of Agriculture, for identification.

CROP ROTATION WITH PINEAPPLES PRODUCES GOOD SUGAR YIELDS

Experience at Grove Farm continues to show benefits from sugar cane-pineapple rotations. Increases in yields of both crops are realized by following one with the other. In 1954, their pineapple yields were among the highest in Hawaii, and the cane yields in fields previously in pineapple were considerably higher than their neighbor fields planted continuously to cane.

Kohala Sugar Company harvested their first cane fields following pineapple this year and made

record yields of sugar. Lihue has rotated limited areas in recent years. Their results have encouraged expansion of the sugar cane-pineapple rotation programs with Hawaiian Canneries Company, Ltd.

The Pineapple Research Institute has conducted studies on land that had been in sugar cane in the Wahiawa district. Pineapple yields of the plant crop following sugar cane were equal to those that had been in pineapple continuously for 60 years.

HARVESTING EXPERIMENTAL PLOTS

REDUCING COSTS OF HARVESTING FIELD PLOTS

“Cut and pull” has long been the traditional procedure for harvesting field trials in Hawaii. After the cane has been cut, each stalk that has extended itself into a neighboring plot is pulled out and returned to the plot in which it originated.

When the stalks are not too long, they can be rather easily segregated and returned to their respective plots. Thus, under conditions of light cane tonnage and fairly short stalks, the cut-and-pull method is not unduly burdensome. In two-year old cane, under heavy tonnage conditions, the effort required to disentangle the long interlaced stalks which cross the plot boundaries, and to return each stalk to its proper source, results in prohibitive harvesting costs. The need for a more efficient procedure led to an investigation of the possibilities of slash cutting.

The slash-cut method requires, first of all, that border effect and invasion from neighboring plots be reduced to an acceptable minimum by providing an adequate guard of the same variety or treatment along the boundaries of the plot destined for slash harvesting. Thus, in an eight-line plot, the two outside lines on each flank serve as guard lines; only the four inside lines are harvested for yield data. By slashing vertically down-

ward with a cane knife, a boundary is cut along a line midway between the last guard row and the first plot row (Figure 22). The area within the plot boundaries thus established by slashing is then determined on the spot by appropriate measurements. All cane falling within these slash boundaries is credited to the plot and all cane outside the slash boundaries is discarded as guard, regardless of origin (Figures 23 and 24). The feasibility of this procedure thus depends to a considerable degree upon the extent to which the weight of stalks migrating outward and inward across the boundary lines tend to balance each other (Figure 25).

The Oahu plantations and one Kauai plantation have cooperated with the Station in the harvesting of nine experiments in which slash cutting was compared with the old cut-and-pull method. An analysis of the data shows that the coefficient of variation is essentially the same for the two methods. The results to date indicate that, under the conditions thus far investigated, slash cutting of experimental plots may be substituted for cut-and-pull harvesting with a substantial reduction in labor requirements and with increased insurance against bias from border effect.



Figure 22. A slash-cut boundary is made by cutting vertically through the mat of cane without pulling cut stalks back to the area where they originated.



Figure 23. Hand-cutting experimental cane after boundaries of plot have been slash cut.



Figure 24. Experimental cane windrowed in plot. Note slash-cut boundaries along guard cane on either side.

Figure 25. A truck, carrying cane from an experimental plot, is weighed, one axle at a time, with Loadometer truck scales.



Figure 26. Handling cane samples at the Waipio Substation.

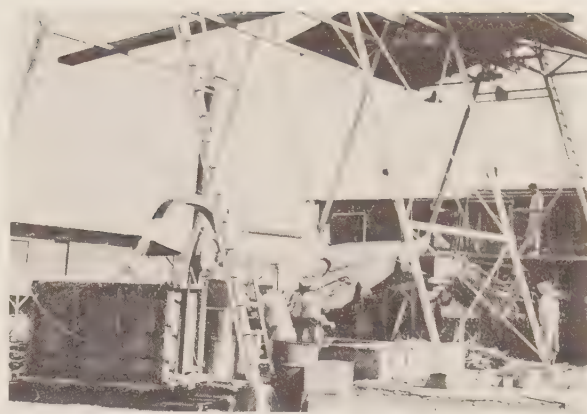
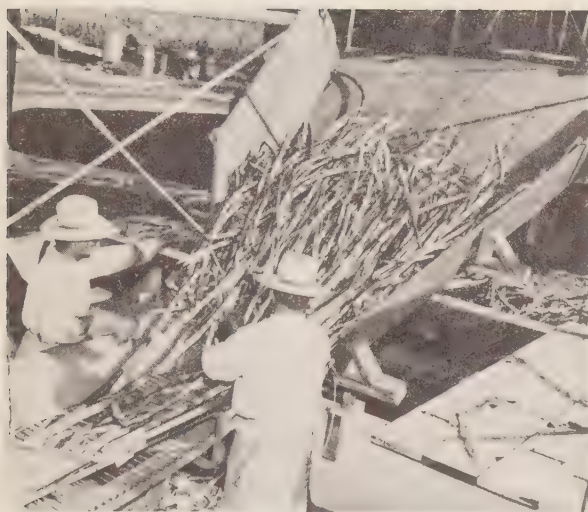


Figure 27. Chopping cane in the ensilage cutter.



Figure 28. Subsampling chopped cane.

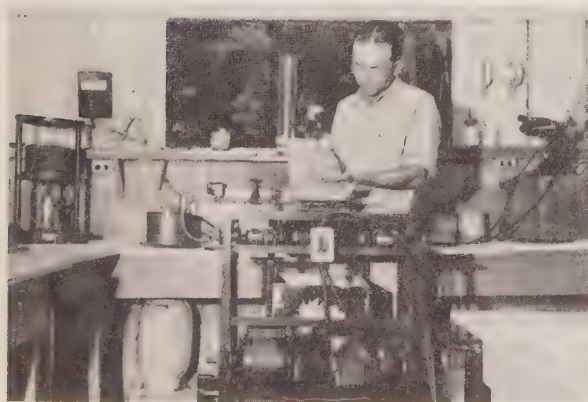


Figure 29. Operating the HSPA disintegrator.

DETERMINING CANE QUALITY BY THE NEW POL RATIO METHOD

The recent development by the Sugar Technology Department of the silage cutter-disintegrator method provides the industry for the first time with a workable procedure for determining pol and fiber per cent cane. Prior to this development, the quality of cane from experimental plots could be appraised only on the basis of juice analyses. Quality Ratio figures based upon juice analyses involve the assumption of identical juice-fiber ratios in the different varieties or treatments under comparison. Since different varieties may differ materially in per cent fiber, and thus in per cent juice, yield data based upon quality ratio figures may be subject to considerable error.

The possibilities of the silage cutter-disintegrator method for analyzing cane from field experiments have been investigated intensively during the past year. The procedure developed in the course of these studies has been designated the Pol Ratio Method.

Under this procedure, a representative sample of cane of 400 pounds or more is drawn from each plot as it is harvested (Figure 26). This sample is delivered to the silage cutter for chopping (Figure 27). By means of a deflector in the discharge spout, a continuous subsample of chopped cane is diverted and accumulated as the cane passes through the silage cutter. After this subsample has been thoroughly mixed, a two-pound sample is removed and placed in a polyethylene container. This two-pound sample may be subjected at once

to disintegrator analysis or it may be held in freezer storage for subsequent analysis (Figure 28).

Pol and fiber per cent cane are determined by combining a known weight of cane sample with a known amount of water, and subjecting the resulting slurry to comminution and diffusion in the HSPA disintegrator to bring the sugar in the cane tissue into equilibrium with the surrounding liquid. This requires about 10 minutes in the disintegrator (Figure 29). Pol per cent cane can then be calculated from an analysis of the dilute juice. Fiber per cent cane is determined by washing the fiber until it is free of soluble solids and drying it to constant weight.

In comparing varieties or treatments, the plot by plot Tons Cane/Acre figures may be multiplied directly by their respective Pol Per Cent Cane figures as determined from the disintegrator analyses. The resulting Tons Pol/Acre figures provide a measure of the sugar per acre grown and lying in the field at harvest. Subsequent losses in the field, cleaning plant and factory would reduce the pol recovered in sugar by the factory to approximately 80 per cent of the tons of pol per acre in the field.

The Island Substations have been equipped and their staff members have been trained to carry out Pol Ratio analyses. As a means of evaluating the quality of cane from field experiments, the Pol Ratio Method promises to replace the Quality Ratio Method throughout the industry as rapidly as the necessary equipment can be provided.

HOPE FOR MORE EFFICIENT, LESS COSTLY EXPERIMENTS

The results of investigations carried out during the past year point to the following conclusions:

1. Under many, and perhaps under most conditions, slash cutting may be substituted for the traditional cut-and-pull method of harvesting plots of eight lines or more without loss of accuracy and with material savings in labor costs.

2. The Pol Ratio Method of analyzing cane provides a more accurate measure of quality of cane from experimental plots than can be had from the traditional Quality Ratio Method of analyzing only the juice. It offers the added ad-

vantage of divorcing the experiment sampling operations from factory operations.

3. These two methods, used in conjunction with an efficient procedure for determining plot by plot weights in the field, offer possibilities for improved accuracy, lower costs, and alleviation of disruptive effects upon other plantation operations.

4. Good statistical planning of experiments will increase the accuracy of the results obtained as well as the amount of information gained per experiment. Industry-wide replication will provide greater usability of results.

MECHANIZATION

PROPOSED CUT-AND-LOAD SYSTEM OF CANE HARVESTING FOR IRRIGATED FIELDS

The Department of Agricultural Engineering has made small-scale attempts to test out a cut-load principle by operating a direct-mounted cutter which discharges directly into an infield transport unit moving along beside it. These tests proved that the cut-load principle would work effectively only if a pickup device were attached to the cutting mechanism so that cane could be cut with the recumbency, and if the picked up cane were cut into shorter lengths to increase the density of the load. These requirements resulted in the design and fabrication of two auxiliary units, a pick-up reel and a rotary sickle bar cross-flow cutter, which enhance the prospects of achieving a successful cut-load system.

A double-ended harvester has been proposed in order to avoid turning at the end of the line and to increase the productivity of the unit.

Two basic types of cut-load systems are envisioned: one, a single-phase transport system in which the harvester discharges cane directly into a wheel-type cane truck running alongside the harvester until fully loaded and then transporting the cane directly to the mill yard; and the other,

a two-phase transport system in which track-mounted infield transports receive cane directly from the harvester and discharge it at the roadside, either into wheel-type cane trucks or into roadside windrows for later grab-loading into cane trucks. The first is suggested for large, dry plantations where cane lines are long and fields are fairly level; the second for wet plantations where cane lines are relatively short and where soft fields are heavily damaged by wheel-mounted cane trucks.

Several other harvest-transport methods involving the use of the cut-load principle have been suggested for consideration. All have in common the same two-way double-ended harvester equipped with pickup reels, cross-flow cutter, and continuous discharge cross conveyor. After careful consideration of six possibilities, a system using crawler-type infield transports to discharge the cane into roadside windrows for grab-loading into truck-trailer cane haulers seemed to be most practical for Hawaiian conditions.

Although the original model will be designed for use in irrigated cane, the same type of machine can be adapted to unirrigated cane.

CUTTER-WINDROWER PROVES ITS VALUE AT LIHUE

The Agricultural Engineering Department has done considerable work on the maintenance and development of side-mounted cutter-windrowers this year. Because Lihue operates six of these machines on a production basis, much of the work has been carried on with this plantation, the results being given to other plantations using the same type of machinery.

Late in 1954, a new elevating conveyor was placed on one of the Lihue tractors. The HSPA provided an auxiliary engine of 100 hp to replace the standard 65 hp engine. Its operation proved so satisfactory that Lihue has begun to replace

their smaller engines with larger ones. The larger engines do a better job of pickup and cutting because the ground knife can operate below the soil surface and still maintain its speed. Ground cutting and pickup are limited by the operator rather than by the machine.

Many other changes have been made to increase the performance of the machines. Structurally, the machines have altered very little. In isolated instances, however, changes have been made in weak sections. In addition, work has been done to improve maintenance accessibility and chain clearances. During the past year, the pickup

assembly has been completely redesigned, and operation of the equipment has demonstrated some of the advantages obtained.

The development had a two-fold purpose: first, to improve the function of the machine—better pickup, less liliko, cleaner work, less damage; and second, to improve the performance of the machine by eliminating sources of trouble. However, elements wear out and fractures occur—a successful cutter program must take these inevitabilities into account. For this reason, much time has been spent on the development of a maintenance program at Lihue.

This program has provided a means of systematically collecting information on machine failures and probable failures. The sources of this information are operators, trouble shooters, mechanics, and supervisory personnel, and the data are indicated on a board, providing a continuous account of the condition of every cutter in the field. A permanent record is also kept, which is regularly inspected by Experiment Station engineers. The story of breakdowns determines which parts should be redesigned.

Another important phase of the maintenance procedure is to provide the shops with an adequate supply of spare parts. Standardization of parts

has been one of the keys to this problem. Many parts on the machine can be grouped into assemblies. When a portion of an assembly fails, a complete new assembly is put in its place. When time is available, the damaged assembly is repaired and put in stock. This procedure, along with the establishment of a night repair crew, has reduced downtime to a fraction of what it was last year.

Many of the developments mentioned above have lessened the burden of the operator, making it possible for him to spend more of his daily effort in doing a better job of cutting. A gauge wheel adjuster has been made that requires merely the turn of a crank. Side chain idler tightening bolts, of new materials, to prevent rust and corrosion, are being investigated.

Figures show a trend toward decreased cutter-windrower unit costs but an over-all increase in harvesting costs. This is understandable when it is realized that the cutter-windrower is a complex machine which does not attempt to compete cost-wise on a mechanical basis with a pushrake. Savings will have to accrue in other areas, such as lower replant and field preparation costs, or increased sugar yield. A cooperative test has been set up to determine these other economic factors.

CUTTER-WINDROWER-TRANSPORT FUNCTIONING ON THE HAMAKUA COAST

This present cutter-windrower-transport was basically a redesign of the original machine. Drawings were provided from which Kaiwiki Sugar Company, Ltd. and Laupahoehoe Sugar Company each had one machine built during the past year (Figures 30 and 31). These two machines are the same except for the following changes on the Laupahoehoe unit:

1. An experimental reel to assist in picking up the cane.
2. A ground knife reversing box to improve performance when cutting in different directions relative to the recumbency.
3. Aluminum sheet for decks and sides of the conveyors.
4. A centralized lubrication system.

One of the major problems is posed by the over-all weight and weight distribution of these machines. The Kaiwiki machine weighed 27 tons

when it was delivered. The calculated ground pressure is 7.5 pounds per square inch, using the over-all area of the track shoes on the ground. Actually, the ground pressure will run considerably higher because of the uneven weight distribution. It will also be higher when operating on side slopes. An effort is being made to redistribute and lighten the weight of future machines of this type.

The new cutter-windrower-transport units are equipped with a single ground knife and pickup tines, as compared to two ground knives and no tines on the original machine. The single knife and tines show to advantage when the operator can stay on the cane line, in that the cane is lifted before it is cut and the knife does not have to operate so close to the ground. This results in less cane left behind, a better trash blanket left on the ground, and less dirt and trash accumulated on the conveyor deck. However, when the operator



Figure 30. The Kaiwiki cutter-transport.



Figure 31. The Laupahoehoe cutter-transport.

is not able to follow the cane line, the cutting operation is not so good as with two knives.

Flotation of the elevating conveyor, by having the hydraulic cylinder work against springs, has not been so satisfactory as expected. Improved performance on the Laupahoehoe machine was obtained by use of an indicator which showed the

operator how much of the conveyor weight was being carried on the gauge wheels.

The increase in track gauge, from eight feet on the original cutter-windrower-transport to nine feet on the new machines, has increased the accessibility of the prime mover, which in turn has improved the ease of maintenance.

THE HSPA CUTTER-WINDROWER-TRANSPORT IN VARIED TESTS

This unit is the original cutter-windrower-transport built for and owned by the Experiment Station. During 1955, the machine was operated on four plantations for the following purposes:

1. To work as a production unit in order to accumulate operating hours and field experience.
2. To train operators for production machines.
3. To mount experimental accessories such as a pickup reel and a cross-flow cutter.

4. To run sugar loss tests.

Approximately 800 operating hours were accumulated on the machine. Mechanical difficulties due to metal fatigue and wear indicated some of the more highly-stressed points and emphasized other problems of a machine of this type. Again, it was made clear that many hours of operation are required before it can be determined whether or not the parts have been correctly designed.

PICKUP REEL FOR HSPA CANE HARVESTERS

The need for a more positive pickup of cane on the HSPA-type cane harvesters, particularly in the unirrigated areas, has been understood for some time.

The first experimental pickup reel, which was installed on the direct-mounted cutter, operated satisfactorily. Pickup performance was improved, especially while cutting down steep grades, and a smooth continuous flow of cane up the elevating conveyor was assured.

Disadvantages of the first model were excessive weight, weakness in critical areas such as the tines,

difficulty in adjustment of position, and insufficient flotation. These points were corrected in the design of a new reel constructed of chrome-molybdenum aircraft tubing and special compression springs. The weight was reduced by two-thirds and the strength at critical points was increased. Flotation on the softer springs reduced shock loading.

This new reel was installed on the cutter-transport for Laupahoehoe and has been operating continuously since April 4, 1955 (Figure 32). Reports indicate a considerable improvement in cane



Figure 32. Left: Front view of the pickup reel mounted on the Laupahoehoe cutter-transport. Right: Side view of pickup reel in operation, showing smooth, even flow of cut cane going up the elevating conveyor.

pickup performance and also note that the reel is indispensable when cutting down steep grades. Power requirements are low, ranging from two to six horsepower.

A reel of the same basic design, but larger in

CROSS-FLOW CUTTER FOR INCREASED DENSITY OF LOAD

The density of a loosely-dropped pile of short cane is greater than that of loosely-dropped long cane, and less conveying equipment and storage space on the portable machinery is necessary when the length of cane is decreased on the harvesting machine.

diameter, is now being constructed for use with the HSPA-owned cutter-transport. It will be used in conjunction with testing the cross-flow cutter and also to determine the effect of a reel on picking up V-cut cane.

Earlier experiments have indicated that cutting parallel with the flow of moving cane will decrease the average length of cane. However, in an attempt to prevent the presence of long stalks of cane which would pass lengthwise between the parallel cutting knives, the Agricultural Engi-



Figure 33. Left: Field operation of the cross-flow cutter on the Kekaha harvester. Right: The harvester discharges the cross-flow cut cane into windrows.

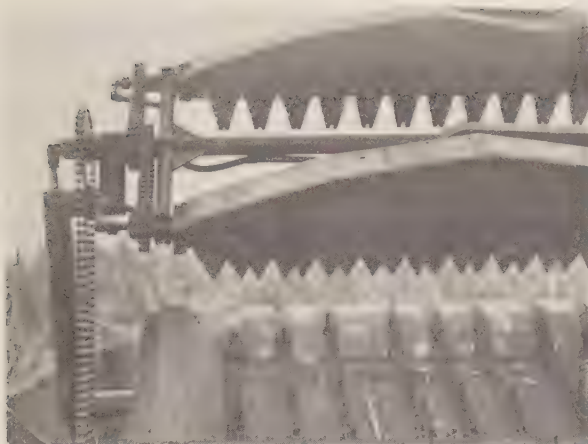


Figure 34. Left: Headshaft rolls for lifting cane away from the conveyor chains of the cross-flow cutter, mounted on the Kekaha harvester. Right: This cane has been cut with the cross-flow cutter.

neering Department has designed a cross-flow cutter which cuts at right angles to the direction of cane flow (Figure 33). This cross-flow cutter is composed of a two-armed reel revolving above the headshaft of a cane harvester elevating conveyor. The reel arms are 180° apart and each arm is composed of two reciprocating sickle-type knives driven hydraulically from a common crankshaft.

The cross-flow cutter was mounted on a cane harvesting machine at Kekaha Sugar Company, Ltd., for its initial field work (Figure 34).

These tests were conducted in well-burned, dry, dense, irrigated cane, and the cross-flow cutter made one cut through the moving cane blanket every four feet of blanket travel.

A comparison of the shortened cane with unshortened cane harvested under the same condi-

tions showed that the weight density of the cane is increased by 41.5 per cent (8.7 to 6.15 pounds per cubic foot) and the average stalk length is decreased by 33 per cent (51 to 34 inches).

All the cuts were clean with virtually no stalk splintering. Neither loss of juice nor short pieces of cane was apparent. No major mechanical difficulties occurred from the operation of the cross-flow cutter. A few long stalks of cane got past the cutters, but it is believed that this fault can be designed out.

These test results indicate that the cross-flow equipment is ready for testing under a variety of adverse cane and weather conditions. Also, many operating hours on the cross-flow cutter will indicate where it can be improved for commercial application.

BASIC RESEARCH ON IRRIGATION FLUMES AND OUTLETS

During the past year, extensive experiments made with light-weight irrigation flumes led to several conclusions on outlets that should be re-emphasized:

1. Relatively large discharges can be secured without the aid of any scooping action.
2. Outlets depending on scooping action tend to collect more trash than those with no scooping action.
3. Erosive tendencies are inversely proportional

to the angle at which the discharging jet strikes the ground.

4. Outlets projecting into the flow reduce flume capacity; for example, the tabbed outlet projects three-fourths of an inch into the flow and reduces flume capacity by approximately 14 per cent over a slope range from one to seven per cent.

The test structure used for the lightweight flumes has been rebuilt to accommodate suitable tests with Waialua concrete flumes.

RUBBER TUBES FOR IRRIGATION

Following completion of a study on a non-rigid irrigation tube to determine its carrying capacity,

a comparison between flume and tube was made. The tube used was an 86-foot section, constructed

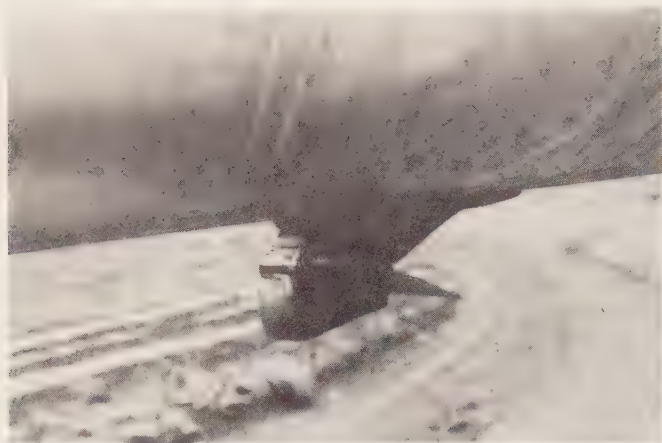


Figure 35. The HSPA draw-down outlet as seen from the bottom of the flume. Note the sliding gate which can be set to give any discharge up to maximum available under specific head conditions. The resulting jet of water goes straight down.

by folding a flat sheet and vulcanizing the edges together in a lap joint. The tube has an inside diameter of 11.09 inches and a wall thickness of 3/32 inch. Outlets, spaced five feet apart, were vulcanized to the tube.

Tests were made under conditions approximating field installations and a gradual inlet section. The carrying capacity in cubic feet per second varied from 3.65 to 5.22, depending upon the slope and head.

Part of the available head is required to maintain the tube in a partially opened position; for example, an eight-inch head is needed for .75 true diameter and a 16-inch head for .90 true diameter. Tubes of this type are very inefficient water conveyors when in a flattened condition, improving as they expand. They could be considered only to convey water under pressure or to meet unusual conditions such as carrying water past low spots in a field.

EXPERIMENTAL LIGHTWEIGHT FLUMES AT WAIALUA

Based on tests made by Stanford Research Institute on using bagasse as an aggregate in concrete, two sections of Waialua No. 2 flume were cast from cement-bagasse mixture. The average weight of these sections was 103.5 pounds, while the standard check flumes weighed 185.3 pounds. The test flumes were installed at Waialua on January 18, and were periodically inspected to determine the effect of field conditions. The following changes in physical appearance have been noted:

1. The flumes were stained dark brown.
2. The outside of the walls became dark up to

the water line, apparently because of saturation.

3. After approximately five months, small depressions appeared in the surface, especially in areas of high fiber content. Deterioration continued until the surface could be scratched with a finger nail.

While this is a definite sign of deterioration, it is too early to predict how it will affect the useful life of the flume. It is quite possible that, after the flume has made this initial adjustment to its environmental conditions, the continuing rate of deterioration could be insignificant.

MOLDED-RUBBER FLUME OUTLETS UNDER STUDY IN THE FIELD

Test work on the molded drawdown outlet has been completed and with the problems of molding in mind, a final design has been made (Figure 35). Outlets will eventually be available for testing by

all interested plantations. The initial samples will be made of GRS rubber, but plans have been made to secure samples made of a wide variety of rubbers.

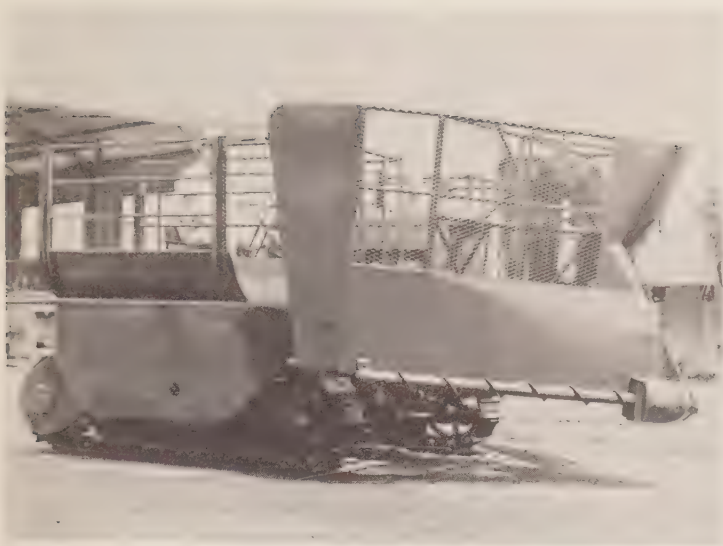


Figure 36. Left: The lightweight-flume pickup machine as originally designed. Right: The lightweight-flume pickup machine in operation on Kauai.

LIGHTWEIGHT-FLUME PICKUP MACHINE

As a result of tests during 1954 of a machine to pick up lightweight irrigation flumes, the basic principles were not questioned, but the method of accomplishing them was varied.

The prime mover proved adequate except for pitching over furrows. This was corrected by lengthening the tracks by three rollers so that the measurement from center line of drive sprocket to center line of front idler was 108 inches. Observations indicated that the scrolls and the vertical knife could be left off.

Distortion of the track frame by a combination of chain load and trash accumulation was overcome by inserting a compression member to resist chain pull and by strengthening the track frame.

From July 18 to August 26, the machine operated at Lihue and Olokele Sugar Company, Ltd. (Figure 36).

Assuming 80 per cent availability, the production of the machine was calculated to be 170 flume sections per day. Again, assuming 20 sections per acre, the performance would be 8.5 acres per day.

The actual performance was approximately 12.6 acres per day, because not all operations were pertinent to all studies.

Recent changes made to the machine increased its performance and markedly decreased the damage done to the flumes. There were no serious mechanical failures. It was necessary to replace the pickup chain once because of severe wear inflicted when it was operating part of the time below the ground line while removing tubed flume.

In order to improve and increase performance, the machine must be made less dependent on manual gauging. Also, the clearing action must be speeded up since the operator had to stop the machine many times to allow the men to catch up. If the operation is improved further, another man would be needed to pick up flumes. In recent tests, the men picking up flume did not have to use cane knives continuously, which is an improvement over the initial tests when, because of poor clearing action by the machine, the men were forced to cut cane away from every flume section.

VARIETIES

THE 1954-1955 CROSSING SEASON IN REVIEW

The crossing season began on November 19, 1954, and ended on January 10, 1955. What promised to be an unusually good year because of adequate moisture during the differentiation period, was adversely affected by a severe cloud-burst on November 28 when more than 16 inches of rain fell at the Kailua field laboratory. This storm caused extensive damage to the breeding collection. Many tassels were broken or so damaged that they did not emerge normally. This resulted in a reduction in the volume of crossing that could be accomplished. Table 2 shows the number of crosses completed.

Table 2
Number of Crosses Completed during 1954-1955 Crossing Season

General melting pot crosses.....	1,435
Leeward melting pot crosses.....	848
Elite melting pot crosses.....	170
Windward makai melting pot crosses.....	513
Windward mauka melting pot crosses.....	353
QR melting pot crosses.....	149
Bi-parental crosses.....	445*
Selfs.....	1
Field crosses.....	168
USDA melting pot crosses.....	29**
Total.....	4,111

*Includes 27 crosses made for USDA and 8 crosses for cytological investigations.

** Crosses for USDA use only.

PRELIMINARY TESTING AT THE REGIONAL STATIONS

The regional station network continued to operate at full capacity in the processing of seedlings through the bunch planting, 5x3, 5x6, 10x15, and 30x30 stages.

The leeward variety station network is undergoing considerable readjustment, not only as to location of testing areas, but also as to the details of the testing program. Future plantings are to be

Table 3
Plantings made in 1955 at Regional Stations

Regional Stations	No. of Flats (No. of seed- lings per flat— 100 to 1000)	5'x3' No. of Sdlg. Plots	5'x6' No. of Sdlg. Plots	10'x20' No. of Sdlg. Plots	20'x20' No. of Sdlg. Plots	40'x30' No. of Sdlg. Plots
Kailua Field Laboratory.....	3,326	1,025	.....	.....	.....	.....
Waipio Substation.....	704	9,660	3,327	133	103	42
Waimano Mauka Variety Station.....	463	4,139	3,637	104	24	.....
Ewa Variety Station**.....	632	10,589	881	124	.....	20
Helemano Variety Station.....	263	2,189	1,497	94	.....	.....
Hilo Variety Station.....	300	5,089	2,241	106	.....	27
Hilo Mauka Variety Station*.....	.....	.....	561	.....	.....	.....
Hamakua Makai Variety Station.....	261	2,215	1,940	98	.....	26
Hamakua Mauka Variety Station.....	150	3,345	1,558	110	.....	20
Kohala Variety Station.....	.....	2,100	1,069	104	.....	20
Kau Variety Station.....	200	2,114	1,969	104	.....	22
Kauai Variety Station.....	202	3,289	1,214	123	.....	26
Total.....	6,501	45,754	19,894	1,100	127	203

* Temporary station, cooperative with Hilo Sugar Plantation Co.

** Station to be returned to plantation in 1956.

carried through the following successive stages: bunch planting, 5x3, 5x10, and 20x20. The last stage will be harvested at two years. At harvest, particular emphasis will be placed upon condition of cane and juice quality. The leeward 40x40 testing of those canes which show promise in the 20x20 stage will be left entirely to the plantations. Table 3 summarizes the year's plantings at the regional stations.

Omitted from Table 3 are the following:

1. Breeding and spreading canes at the Kailua Field Laboratory.
2. "Super" selections—4,592 (5'x3') plots at Kailua and Oahu Substations.
3. Field nurseries under special conditions on plantations:

Hawaiian Ag.	100 flats
Hutchinson.	100 flats
	200 flats

4. 5'x3' plots under special conditions on plantations:

Lihue.	1,437
H. C. & S.	1,548
Kohala Sugar.	1,849
Hawaiian Ag.	1,136
	5,970

5. 5'x6' plots under special conditions on plantations:

Lihue.	449
Kohala Sugar.	39
Hutchinson.	23
	511

VARIETY TESTING ON PLANTATIONS SHOWS DECLINE

The difficulties facing the industry in respect to the conducting of field experiments are reflected in a decrease in the number of tests installed. The number of 10x15 and 10x20 plantings made on the plantations dropped to the lowest level in six years. The volume of 30x30, 40x40 and replicated testing increased slightly over the previous year, but it still falls short of what is needed to evaluate within a reasonable period the promising candidates that now await evaluation. Thus the

difficulties which the plantations are encountering in obtaining reliable yield data from variety tests impose a serious bottleneck upon the breeding program.

Table 4 shows the number and distribution by island of preliminary tests installed by the plantations.

Table 5 shows the varieties which have been installed in replicated tests by the plantations during the past year.

Table 4
Number of Preliminary Tests Installed by Plantations 1954-1955
(Fiscal year ending June 30)

Type of Test	Kauai	Oahu	Maui	Hawaii	Total
10x15 and 10x20	17	7	10	24	58
30x30 and 40x40	19	13	9	22	63

DISTRIBUTION OF SEED

Table 6 shows the volume of seed supplied by the regional stations for the plantation testing

program and for plantation spreading of new varieties.

CYTOLOGICAL INVESTIGATIONS AIM AT UNDERSTANDING CANE

Dr. Samuel Price continued his investigations on the cytogenetics of sugar cane at Beltsville, Maryland, and at Canal Point, Florida, under the cooperative USDA-HSPA project. In addition to making chromosome counts on a large number of commercial varieties and breeding canes, Dr. Price is studying the phenomenon of doubling of sets of chromosomes in certain interspecific crosses within the genus *Saccharum*.

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Table 5
Replicated Variety Tests Installed by Plantations
July 1, 1954 to June 30, 1955

Variety	Kauai	Oahu	Maui	Hawaii	No. of Entries Total
H 109.....	..	1	..	..	1
32-1063.....	..	..	..	1	1
8560.....	..	..	..	4	4
37-1933.....	1	3	1	..	5
38-2915.....	3	2	1	7	13
4443.....	..	..	..	3	3
39-3633.....	..	..	..	1	1
7028.....	4	..	..	2	6
41-3340.....	..	..	..	5	5
44-2772.....	..	..	..	4	4
3098.....	3	2	..	11	16
3171.....	..	1	..	..	1
45-369.....	..	..	..	1	1
2120.....	1	..	..	..	1
46-525.....	..	..	..	1	1
564.....	..	..	..	3	3
47-2060.....	1	..	..	..	1
2800.....	1	1	..	..	2
48-152.....	..	..	..	2	2
3594.....	..	..	..	1	1
4178.....	..	1	..	..	1
49-5.....	..	..	..	3	3
104.....	..	..	..	6	6
118.....	..	..	..	1	1
134.....	..	..	..	5	5
612.....	..	..	..	1	1
722.....	..	..	..	1	1
3533.....	..	1	..	..	1
3998.....	..	1	..	..	1
Totals for 1954-1955.....	14	13	2	63	92
1953-1954.....	24	7	..	48	79
1952-1953.....	12	24	8	106	150

Table 6
Seed Shipments to Plantations
July 1, 1954 to June 30, 1955

Source	For Seed Nurseries— Tons	For Grade A and Special Tests—Tons	For 10x20 No. of Plots	For 30x30 and 40x40 No. of plots
Kailua Field Laboratory.....	..	.05	..	..
Waipio Substation.....	11.20	3.70	1,889	20
Waimano Mauka Variety Station.....	2.55	1.80	..	51
Helemano Makai Variety Station.....	..	..	..	43
Helemano Mauka Variety Station.....	..	..	..	12
Hilo Variety Station.....	9.08	.03	913	1
Hamakua Makai Variety Station.....	.68	..	472	..
Hamakua Mauka Variety Station.....	.08	..	117	2
Kohala Variety Station.....	..	..	24	..
Kau Variety Station.....	3.99	..	80	..
Kauai Variety Station.....	.13	..	13	..
Totals.....	27.71	5.58	3,508	129
Total 1953-1954.....	20.93	5.14	4,646	33

CANE VARIETIES PASS IN REVIEW

A total of 28,914 acres, or 13.24 per cent of the total cane acreage, was planted during 1954. Since the all-time record of planting in 1951 (43,893 acres or 20.13 per cent), there has been a steady decline in the area planted. This decrease may be credited largely to improvements in harvesting techniques.

For the fourth consecutive year, 44-3098 headed the list of varieties planted. Of the 8398 acres planted to this variety, 8000 acres were on the island of Hawaii. 37-1933 was a close second with 6906 acres planted during 1954. 38-2915 was a close third with 6682 acres planted.

On Oahu, plantings of 38-2915 accounted for 55 per cent of the area planted; on Maui, 46 per cent; on Kauai, 36 per cent; and on Hawaii, about 12 per cent. The fourth ranking variety planted was 39-7028, concentrated mainly on the island of Kauai. These four varieties accounted for 86 per cent of the area planted. The remaining 14 per cent was divided among the following, in descending order of acreage planted: 41-3340, 38-4443, 39-4753, 44-2772, 32-8560, 39-3633, 46-564 and 49-134. For all of these, the area planted exceeded 100 acres.

THE VARIETY PICTURE—1955

The following summary is based upon preliminary yield trials (30x30, 40x40) harvested at the regional variety stations, and upon preliminary and final tests harvested on the plantations. The major ecological zones will be considered in their geographical order beginning with windward Kauai.

Windward Kauai—Makai-Irrigated: In spite of its heavy tasseling, 37-1933 still serves as the standard in the better lands. When planted or ratooned after June, it escapes first-season tasseling, and usually comes through with satisfactory yields. 39-7028, a light tasseler, is being substituted for 37-1933 in fields which would otherwise be subject to heavy tasseling. Unless 39-7028 can be well ripened, it is likely to fall below par in juice quality. This tendency may prove a source of difficulty in wet harvesting seasons.

44-3098 has not come up to expectations at Lihue, but it has given a somewhat better account of itself in the makai fields of Grove Farm and Kilauea Sugar Plantation Company.

Candidates for further testing: 45-2608, 48-546, 48-4178, 48-4605, 48-4899, 49-5, 49-134, 49-3404, 49-3533, 49-3945 and 50-2606.

Windward Kauai—Middle Belt-Irrigated: In this district, the major varieties are 39-7028 and 44-3098, with some 37-1933 in the more fertile fields, and some 39-3633 in the Hanamaulu Division of Lihue and at Kilauea. Here again, 44-3098 has not done as well at Lihue as at Grove Farm and Kilauea.

Candidates for further testing: 45-2120, 47-1992, 46-1463, 48-546, 48-4178, 48-4605, 48-4899, 49-5, 49-134, 49-3404, 49-3533 and 50-2606.

Windward Kauai—Mauka-Unirrigated:

In terms of total acreage, 37-1933 heads the list with 71,207 acres. This represents a gain of only 11 acres over 1953, which indicates that 37-1933 has reached its maximum.

Still in second place is 44-3098 with 53,687 acres, reflecting a gain during 1954 of 5244 acres.

38-2915 was in third place for the second year, gaining 3199 acres to a total of 38,684 acres.

Fourth and fifth places fell to 32-8560 and 32-1063, with 12,693 acres and 12,668 acres, respectively. During the year, 32-8560 lost 8298 acres while 32-1063 lost 3215 acres.

Red rot disease in 38-2915 has discouraged the planting of this variety in the upper fields of Hanamaulu and is of some concern in other mauka fields on windward Kauai. 39-7028 has thus far shown no evidence of red rot, and is proving to be a strong standard in this district.

Candidates for further testing: 39-4753, 45-2120, 49-3404 and 50-2746. The lack of outstanding contenders has led to an intensification of preliminary testing in this region.

Leeward Irrigated—Mauka and Middle Belt: 38-2915 is considered the standard variety in this region, with the exception of the most fertile fields, well supplied with irrigation water, where 37-1933 still holds its own. 44-3098 has proved disappointing in the leeward irrigated districts and is no longer being planted.

Candidates for further testing: 45-2608, 45-2860, 48-3649, 48-3845, 48-4178, 48-4646, 49-134, 49-3404, 49-3533, 49-3637, 49-3961, 49-3945, 49-4267 and 50-2606. For thin soil conditions and other situations conducive to light tonnages and good juices, 47-2800 may prove useful.

Leeward Irrigated—Makai: 37-1933 is still the standard variety for this region, but 38-2915 is invading this zone, particularly at HC&S, Oahu Sugar and, to a lesser extent, at Waialua and Pioneer Mill.

Candidates for further testing: 45-2608, 47-2800 (for light tonnage, good juice fields), 48-4178, 48-4646, 49-118, 49-134, 49-3404, 49-3533, 49-3637, 49-3945, 49-4267, 50-2145, 50-2606 and 50-5665.

Hamakua and Kohala—Mauka: 38-4443 remains the standard in the extreme mauka zone of

Kohala and at Paaupau Sugar Plantation Company. In the better fields, 38-2915 is the standard. 44-2772 has done well and is being planted extensively as a replacement for 38-2915, especially in the poorer fields.

Candidates for further testing: 41-1045, 46-525, 49-612 and 49-784.

Hamakua and Kohala—Middle: In this district, the standard varieties are 38-2915, 39-4753, 41-3340 and 44-3098. At Kohala, where 39-4753 occupies a considerable acreage, it is giving way to 41-3340. 44-3098 is confined to the best fields of this district. 49-104 is being spread as rapidly as possible on the basis of its excellent juice quality and good yields in tests harvested to date.

Candidates for further testing: 45-2654, 48-546, 49-5, 49-104 and 49-134.

Hamakua and Kohala—Makai: Standard varieties are 38-2915, both irrigated and unirrigated, 41-3340, especially under droughty conditions, irrigated and unirrigated, and 44-3098, in the better areas not subject to severe drought. Some 45-2120 has been planted in this region. Trial plantings of 49-104 and 49-134 are also being made in the makai lands other than those subject to severe drought.

Candidates for further testing: 45-2120, 46-564 (in droughty areas), 48-527, 48-546, 49-5, 49-104 and 49-134.

Hilo—Mauka: 44-3098 is still the standard, except toward the Laupahoehoe end of this region where 38-2915 is preferred.

Candidates for further testing: 44-2772 and 49-612 (as a replacement for 38-2915) and 50-723. The scarcity of candidates in this district points to the need for increased emphasis on 10x20 and 40x40 testing.

Hilo—Middle and Makai: Here 44-3098 is a well-entrenched standard. Some 39-3633 is grown and 45-2708 still has support for the better growing conditions. 39-7028 has been planted in the Kapoho district of Olaa because of its resistance to leaf scald and to drought. 49-134 has been extended to block plantings for further observation.

Candidates for further testing: 48-546, 49-5, 49-104, 49-134 and 50-2036.

Kau—Mauka: 44-3098 is the standard, with some 46-564 in the most extreme mauka fields and 38-2915 in some of the lower, better drained fields of this district.

Candidates for further testing: 44-2772, 46-564, 49-5, 49-118, 49-134, 49-3646 and 50-723.

Kau—Middle: Here, also, 44-3098 is a strong standard, with 38-2915 being planted in droughty fields. 49-118 is being spread to block plantings.

Candidates for further testing: 41-1045, 49-5, 49-118, 49-134, 49-784 and 49-3646.

Kau—Makai: 41-3340 is regarded as the standard for the droughty areas. Some 38-2915 has been planted in some of the less droughty fields. 46-564 is being tried in block plantings because of its drought resistance.

Candidates for further testing: 46-945, 49-5, 49-118 and 50-723.

PRACTICAL CONTROL OF TASSELING IN THE OFFING

The Hawaiian sugar industry is moving toward practical control of flowering at a satisfactory rate. In certain regions, control by withdrawing irrigation water seems to be the most promising method, while in other regions of high water table and high rainfall, control by sprayed chemicals has reached the stage of economic practicability. The prospect for this year is that there will be several thousand acres under some form of control.

An important cooperative experiment on tassel control has been organized by the Plantation Department of American Factors, with several plantations outside of the American Factors group participating. The test will compare flower control

and harvest results on plots receiving controlled drought, high nitrogen, CMU, maleic hydrazide, Versene, and no treatment (check). The results of this test should hasten the widespread use of some treatment to reduce losses due to flowering.

The success of flower control depends upon two properties of the sugar cane plant: first, a very narrow time interval during which flower initiation takes place; and second, no tendency to flower again for a year, once the flower initiation has been suppressed.

A survey of dates of several commercial varieties was made by the Island Representatives last fall. Rather remarkable results came from this study.

1. The date of first flower buds visible under the hard lens is the same for all varieties in all locations (September 20–23).
2. All varieties initiated at the same time.
3. By selecting large stalks, as much as 100 per cent flowering was observed, even in varieties often considered moderate or low-flowering types.

The study reported in Table 7 illustrates this last point. Although final tassel counts made in February may be well below 50 per cent, 80 to 100 per cent of the big stalks in September actually flowered. This may result in larger sugar losses at harvest than would be predicted from final tassel counts.

Table 7 Tassel Bud Determination Study and Final Tassel Count in Ratoon Crop

Plantation	Field	Variety	Crop Started	Dates and Number of Flower Buds per 20 Stalks																% Bud Determ. by 10/28/54	Final % Tassel Count on 2/16/55
				Sept.				Oct.													
				13	16	17	20	23	27	30	4	7	11	14	18	21	25	28			
Olaa.....	F&I	44-3098	12/53		0			2		10		15		14		17		18	90	31	
Olaa.....	107-108	32-8560	11/53		0			2		8		13		14		18		18	90	39	
Hilo Sugar.....	36	44-3098	1/15/54			0			2	8	10	14	13	8	12	14	14		70	10	
Pepeekeo.....	7	44-3098	2/15/54				0	1	5	4	4	3	9	8	7	4	4		20	11	
Laupahoehoe..	13B	38-2915	6/ 1/53	0	0		0	2	5	10	12	11	19	20	20				100	43	
Kaiwiki.....	31R	44-3098	2/12/54				0	0	5	8	14	14	15	17	18	16	16		80	43	
Kaiwiki.....	6R	44-3098	10/23/54				4	1	12	11	15	14	17	19	19	18			90	68	
Hamakua.....	16RK	38-2915	2/19/54				0	0	1	8	14	14	16	14	14		17	16	80	51	

TIME OF EMERGENCE OF TASSELS VARIES

The study illustrated in Figure 37 demonstrates the wide range in time of the development of flowers, all of which probably initiated on about the same date.

All control stalks which were examined on October 4 were in bud. Therefore, it is assumed that a very large percentage of all the stalks examined on November 26 had been in bud on October 4. The differences in rate of flower development are very striking and help explain how night lighting from September 5 to September 15 stops all flowers, including those which appear late the following spring. Of the 20 stalks tagged on October 4, only one failed to flower. Among the others, two had fully developed tassels and 17 were in the categories pictured in Figure 37.

FLOWER CONTROL BY DROUGHT AND BY CHEMICAL SPRAYS

Of all the chemicals studied at Makiki and throughout the plantations, CMU, maleic hydrazide, and Versene showed the greatest economic possibilities of controlling flowering. Chemical control was excellent in some instances. Versene solutions are strongly alkaline and will corrode materials like aluminum.

A detailed study at Makiki on the timing of withdrawal of irrigation water has completely

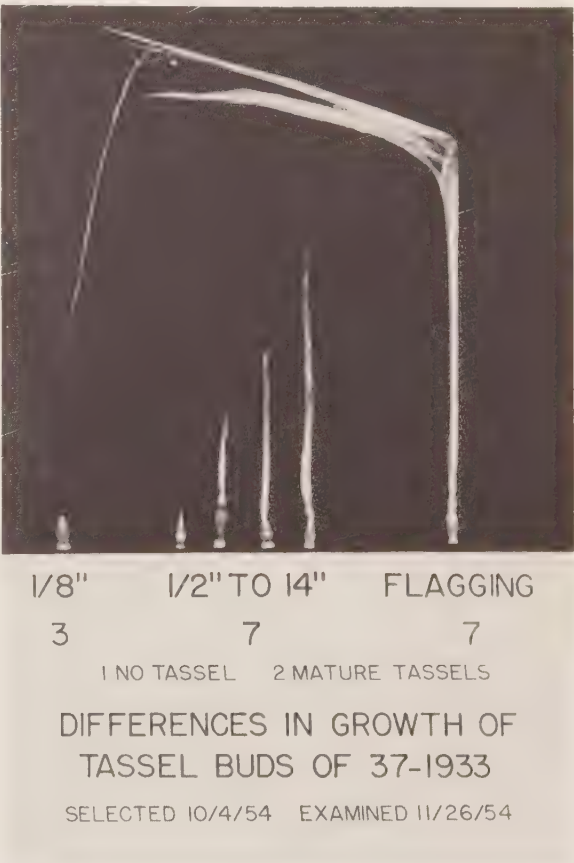


Figure 37

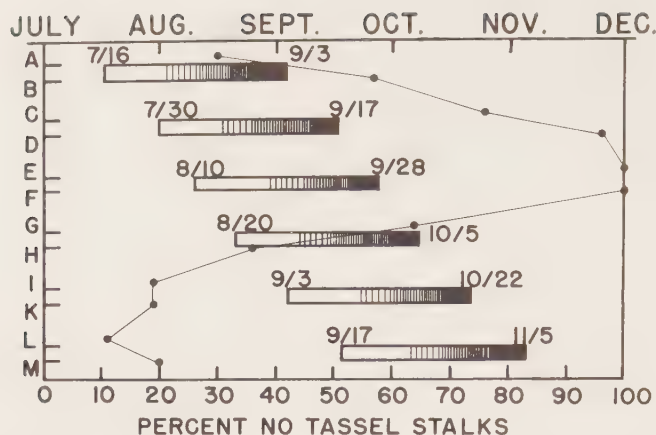


Figure 38. Effect of a seven-week dry period on tasseling.

supported the conclusions of the previous year that water should not be applied between August 10 and September 21. The extreme sensitivity of flower initiation to moisture level is illustrated in Figure 38. All plots were subjected to the same

total drought period of seven weeks. A shift of 10 days in time of drought made the difference between poor control and perfect control. Putting the water back on as early as September 17 resulted in as much as 20 per cent tasseling.

DOES ENVIRONMENT AFFECT TASSELING?

Extensive studies made in Hawaii in collaboration with the USDA brought out the following interesting facts:

Effect of Climate Upon Tasseling: A test that compared the effects of two different climates on tasseling, set up by interchanging plants between Kailua and Waipio on different dates, showed that climatic conditions prior to September first did not affect tasseling. It was also shown that plants at Kailua gave earlier evidence of tassel differentiation, faster tassel development, and

greater percentage of full tassels than did plants at Waipio.

Effect of Soil on Tasseling: A pot test at the Experiment Station showed significant differences in percentage of tassels between "tasseling" and "non-tasseling" soils from Kekaha. The addition of materials, such as Krilium, gravel, bagasse and vermiculite, to the "non-tasseling" soil tended to increase tasseling.

Further experiments are under way this year to amplify and clarify last year's observations.

WATER DEVELOPMENT

GROUND-WATER TIDES STUDIED

An intensive theoretical study of the relationship between permeability and the lag and damping of tides progressing from the ocean inland across ground-water bodies, was made at Scripps Institution of Oceanography at La Jolla, California, with the assistance of Walter Munk of that Institution and George F. Carrier of Harvard University.

Theoretical solutions have now been developed by several different mathematical approaches for a variety of structural conditions as tabulated below.

The tide responses predicted for various depths by the most important solutions are graphed in Figure 39. The lack of solutions for aquifers of small to moderate length-depth ratios is not serious in Hawaiian conditions. Solutions for aquifers whose depth is of the same order as the distance of measuring points from shore would, however, be highly desirable. Ground-water tidal behavior on the Maui isthmus indicates an intermediate response between deep-aquifer and shallow-aquifer behavior for stations at a distance from the shore approaching the ocean depth, suggesting the effect

Solution	Limiting Conditions		Slope of ocean btm.	Compressibility
	Distance/Wave length from shore/of tide	Aquifer/Distance depth/length from shore		
1.....	Moderate to Great	Small	Any	Nil
2.....	" " " "	Small	Great	Any
3.....	Any	Great	Great	Any
4.....	Any	Great	Great	Nil
5.....	Moderate	Great	Great	Any

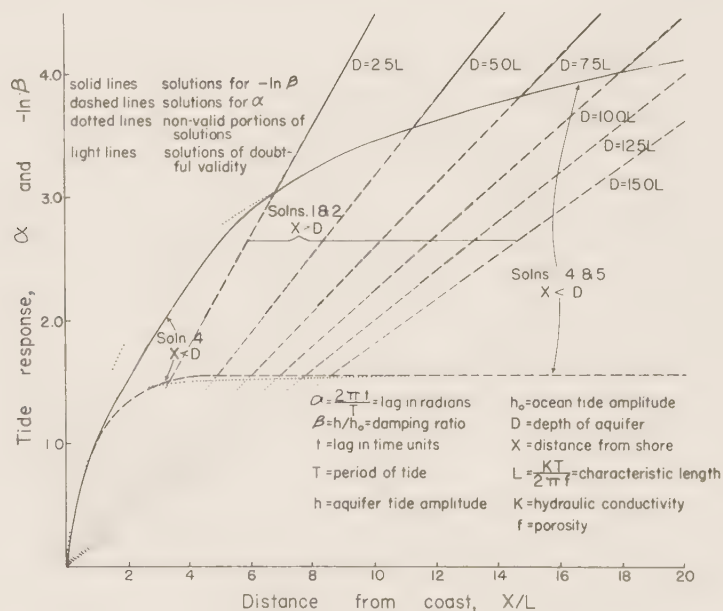


Figure 39. Principal solutions for ground-water tide response in long aquifers with horizontal ocean outcrops neglecting compressibility.

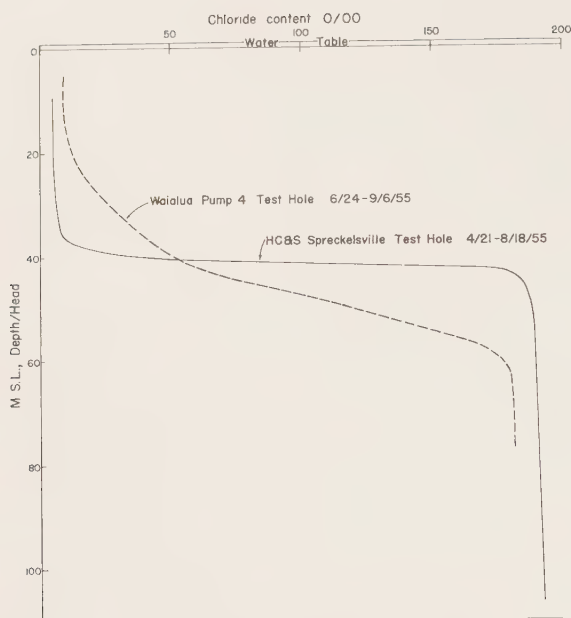


Figure 40. Variation of salinity with depth in mixing-zone test holes.

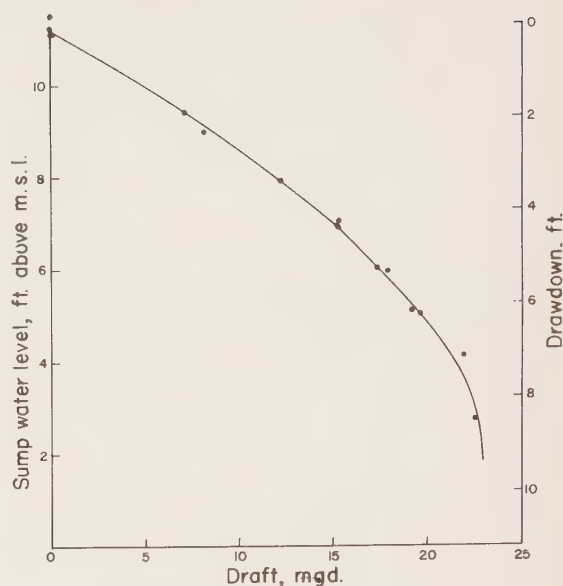


Figure 41. Draft-drawdown relations at Waialua Pump 17.

of a limitation of permeability at the level of the ocean floor. There is a possibility that the fairly simple mathematical methods of Solution 5 may

be extended to provide a deep aquifer solution where the distance of the measuring station from shore is not too small.

MIXING ZONE INVESTIGATIONS ON MAUI

A high tidal variation in salinity in some of the tubes in the HC & S Spreckelsville mixing-zone test well on Maui necessitated sample accumulation over tide periods. Equipment for uniform continuous sampling, independent of tide stage, has been installed and is now being tested.

The average salinity at various depths sampled in the Spreckelsville well indicates a very sharply curved sigmoid mixing curve, centered at a depth

very close to 40 times the head as predicted by the Ghyben-Herzberg theory. Preliminary samples from a new mixing-zone test well at Waialua Pump 4, Oahu, indicate a much deeper centering of the mixing curve, suggesting a rather extreme dynamic modification of Ghyben-Herzberg condition.

A comparison of the two curves is shown in Figure 40.

NEW WELLS TO GET MORE WATER

New Waialua Pump 17: A new Maui-type well, Pump 17, has been completed by Waialua in Opaeula Gulch. The well consists of a vertical shaft communicating with a pump room from which a sump 16 feet deep was excavated, and a single tunnel 208 feet long. The final capacity during construction was $22\frac{1}{2}$ mgd, and as the design capacity is 14 mgd, there is allowance for a substantial drop in head from the 10- to 11-foot

levels so far measured, as shown in Figure 41.

Waialua Pump 4 Expansion: Waialua is at present engaged in additional development at Pump 4 to permit expansion of pump capacity from 9 to 14 mgd.

Although the head is fairly low at Pump 4, the additional development is being provided by a system of shallow drilled wells with gravity collection to a central sump, in contrast with the

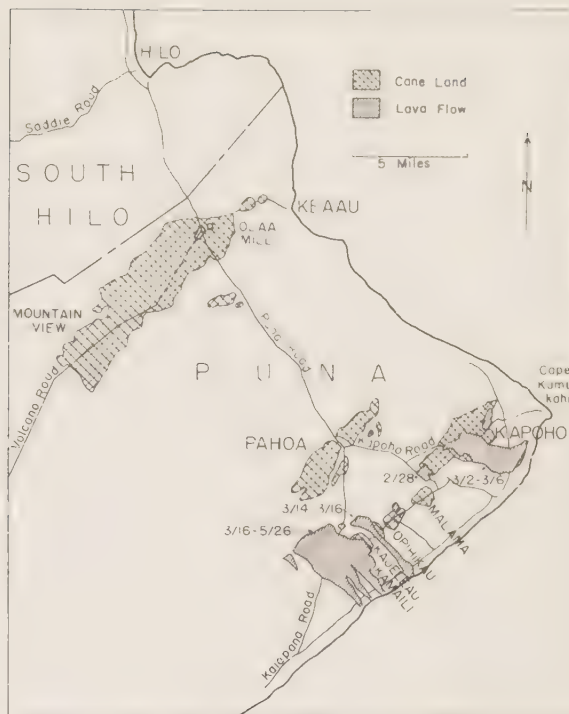


Figure 42. Map of Puna District, showing relation of 1955 lava flows to cane fields.

practice of the last several decades that would have called for a skimming tunnel. The well system will, if successful, cost very much less than the alternative tunnel.

McBryde Lawai Well Completed: The 5 mgd

Lawai well of McBryde Sugar Company, Ltd., has now been equipped with a pump and tested successfully. Long period performance has not yet been required because of adequate surface water supplies and rainfall.

DYNAMIC GEOLOGY

This year, for the first time, direct damage to cane and cane lands was caused by the eruption of a Hawaiian volcano. Kilauea volcano erupted from February to May on its east rift in Puna, a rift which has been active for only two days since 1840: below sea level for one day in 1884, and at an altitude of 3000 feet for one day in 1923.

The 1955 eruption began with a series of earthquakes apparently centered around the area on the Kapoho-Pohoiki road between the junction of the Kapoho road and Malama. The first lava outbreak occurred in this area on February 28, but was short-lived. On March 2, lava broke out in the cane fields on the Kapoho section and flowed over cane fields toward the ocean. This activity continued until March 6. Large areas of cane were covered with lava, and many hundreds of acres of cane were burned.

Activities started again on March 14 at Kaulaeau. Here again, sugar cane was covered with lava, and much of the hitherto untouched parts of this section were burned. The outbreak continued until the lava reached the ocean. Activity ceased here on March 16.

On March 16, other outbreaks began which eventually covered most of the sugar cane fields of the Kamaili section. Here a series of flows continued until May 26. Three flows reached the ocean and a vast area of land was covered with lava. Traffic was disrupted on numerous occasions when lava crossed the government road.

Summarizing the losses in sugar cane: some 718 acres were covered with lava, and 1089 acres were almost totally lost by burning.

The extent of the various flows in relation to cane land is shown in Figure 42.

WEATHER

ARTIFICIAL RAIN RESEARCH

Answers to a number of questions have come out of the cloud physics project during the past year.

Although seeding clouds from aircraft has been ruled out as impractical, ground seeding operations loom up for the future as possible means of obtaining increased rainfall. Pilot experiments on this project were carried out last year to determine its feasibility, and the results were very satisfactory. General application of the techniques,

however, would require heavy expenditure and must, therefore, be approached cautiously. Since the results from this work would have wide application, possibilities of public support for its continuation are being investigated.

In November 1954, the matter was brought to the attention of the President's Advisory Committee on Weather Control, who approved the project for Federal support.

PROJECT SHOWER—AN INTERNATIONAL STUDY

In the fall of 1954, "Project Shower" was carried out in Hawaii with seven research organizations in America and abroad participating. This work was a culmination of cooperative associations fostered by the Meteorology Department during the past four years. It was a large project involving 27

people (Figure 43) and an estimated combined cost of \$500,000. No additional expenditures from local funds were necessary.

The purpose of the project was to capitalize on the individual progress in cloud physics which had been made in various parts of the world. It was



Figure 43. Project Shower scientists confer in Hawaii in late 1954. Part of an inter-nation cloud physics project, sponsored by seven organizations with scientists from five countries, this group includes Kenneth Spengler, Executive Secretary of the American Meteorological Society; Dr. E. J. Workman, President of the New Mexico School of Mining and Technology; Capt. Howard T. Orville, USN, Chairman of President Eisenhower's Advisory Committee on Weather Control; W. A. Mordy; Capt. Fred Berry, USN, Advisory Committee on Weather Control; and Dr. Eric Eriksson, University of Stockholm.

felt that important progress in rain research could be gained by obtaining a number of specialized measurements in the same cloud conditions.

This program has now been carried out, and the information gathered will be published. Because of the amount of data collected, general interpretation of the information will have to await this assembling.

Much, however, has already been done with

specific measurements made during the progress of the work. Good measurements of the liquid water content of our clouds, drop size range, temperature conditions and chemical composition are now available, as are also many details about the raindrop nuclei.

These measurements eliminate much of the guesswork from the appraisal of cloud seeding possibilities in Hawaii.

TREES DRIP WITH WATER

One very practical outcome of the Project Shower measurements is an increased understanding of the role that trees play on Hawaiian watersheds. From measurements of cloud water content and cloud droplet size, it was possible to deduce the amount of water which might be obtained by the collection of these droplets on tree branches or other obstacles placed in their path (Figure 44). These calculations indicated that much larger amounts of water are available as *accessible* cloud water than as rainfall. During the past summer, a cooperative experiment with the Hawaiian Pineapple Company was begun on Lanai, made possible by the construction of a new road along the crest of the mountain.

Initial measurements of the amount of drip from trees in cloudy conditions were made and compared with rainfall. Several times as much water was measured from "fog drip" as from rainfall (Figures 45 and 46). Table 8 shows some of the measurements taken in the months of June, July and August.

Initial computations show that it may be economical and more efficient to collect this water by

means of artificial barriers rather than by tree planting.

A tower has been constructed on Lanai for the purpose of testing materials and methods of fog drip collection. The results of this work indicate the possibility of an important new source of water for some areas of the Islands.

Table 8

Date		Rainfall Inches	Fog Drip Inches	Fog Drip Gals/tree*
June	1- 7	0.18	0.51	
	7-14	0.06	0.11	
	14-21	0.10	0.75	
	21-28	0.17	1.44	
	28-July 5	0.29	2.73	
<i>Gauges relocated under different tree</i>				
July	7-12	0.01	0.45	
	12-19	0.03	1.97	
	19-26	0.85	0.68	
	26-August 2	0.54	1.73	
	2- 9	0.81	2.68	191.2
August	9-16	0.21	2.14	439.3
	16-23	2.34	2.64	389.3
	23-30	0.05	0.38	124.0

*Measurements began August 2 after watershed was constructed.

FIRST RESULTS OF THE EVAPOTRANSPIRATION EXPERIMENT

Since weather, to a large degree, controls evaporation and transpiration and, consequently, irrigation, control studies were initiated in 1954 to evaluate the importance to irrigation of weather factors. It is believed that practical methods for irrigation control can be worked out using meteorological measurements alone. Such methods offer the advantages of simplicity and economy, plus the possibility of rather accurate evaluation of water requirements in various areas from old meteorological records. Such information is also useful in land classification and evaluation.

An elaborate meteorological setup, discussed in last year's Annual Report and greatly expanded during the past year, has been described by a Department of Agriculture official as one of the best of its type in the United States.

The objectives of the work are to determine:

1. How much water is used by grass, pineapple, and sugar cane cover each day.
2. What meteorological measurements best show these water losses.
3. What extension of this information can be made in the control of irrigation and in the planned



Figure 44. Fog drip experiment installation at Lanaihale.

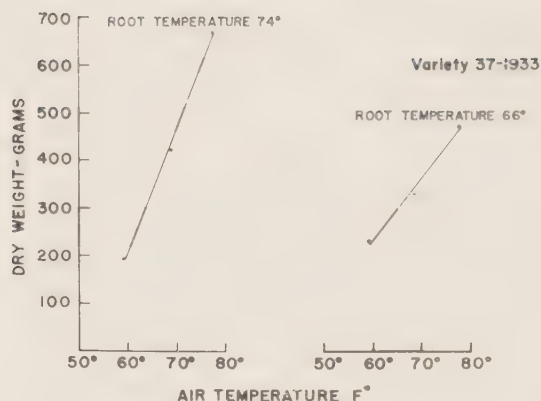


Figure 45. Rain gauges placed under Norfolk pines on the island of Lanai indicate that several times as much water is obtained from fog drip in this area as from rainfall.

Figure 46. A watershed was constructed under a Norfolk pine on the island of Lanai for the measurement of fog drip. Data for June, July and August are shown in Table 8.



Figure 47. Dry weight of cane (37-1933) as influenced by root and air temperatures.



use of available irrigation water.

4. An evaluation, in cooperation with the Agronomy Departments of both institutions, of methods of soil moisture measurements.

Data have now been gathered for 15 months. They consist of comparisons of open pan evaporation, moisture consumption from a grass-covered tank, comparisons with selected meteorological

measurements, and comparisons of soil moisture measurements made cooperatively by the Agronomy Departments of PRI and HSPA.

These measurements represent some of the first fundamental data on this important subject which have been gathered in Hawaii. Work on the sugar cane cover will begin this year when irrigation water becomes available.

AIR POLLUTION POSSIBILITIES IN HONOLULU STUDIED

In early 1955, the Standard Oil Company requested the Meteorology Department to prepare a report covering the relation to air pollution problems of the various elements of the climates of the Islands. As a result, the Meteorology Department collaborated with the Stanford Research Institute in studying the many possibilities which

might result from the establishment of a new refinery here.

Results indicated that Honolulu has few of the weather conditions which prevail in the areas on the mainland where smog is a problem. A detailed account of this work is available in the HSPA Library.

ROOT AND AIR CLIMATE AFFECT CANE GROWTH

During the past year, some data from the climate house have been analyzed and graphed by the Department of Physiology and Biochemistry. Figure 47 shows the striking effect of root temperature upon the response to air temperature.

A decrease of 8°F. in root temperature results in a 40 per cent drop in response to changes in air temperature. This phenomenon may have a pronounced effect on the final evaluation of the modified day degree.

WEED CONTROL

A NEW 2,4,5-T ARCADE

A low-volatile ester of 2,4,5-T is dissolved in an aromatic oil and then emulsified with one-half its volume of APC, using the regular plantation emulsifying technique. This formulation, diluted

to four times its volume with water containing SSA, has been effectively applied as a pre-emergence and contact treatment where grasses and broadleaf weeds have gotten out of control.

CMU, 2,4,5-T, WATER, AND AROMATIC OIL FORMULATION IS POTENT

In this new and potent formulation of CMU, low-volatile ester of 2,4,5-T, water, and aromatic oil, the CMU does not settle out on standing. The mixture may be put together without complicated mechanical equipment. Simply dissolve the ester in the aromatic oil and set it aside while preparing a smooth slurry of CMU, APC, and water. Then, with vigorous stirring, add the prepared oil solution to the CMU slurry in a slow, steady stream.

To insure a non-settling dispersion, the oil phase in this formulation is made to 67 per cent by volume and the aqueous phase to 33 per cent by volume.

If tarry matter and insoluble, gummy substances are present in the aromatic oil, these impurities may selectively seek out and adhere to the dispersed CMU particles, thus forming a grainy emulsion.

SLOW-SETTLING MIXTURES OF CMU AND WATER AVAILABLE

Soft, thin mixtures of CMU and water can be produced which give very slow settling and prevent formation of a hard cake of CMU in the bottom of the container on standing, and which, with gentle agitation, maintain suspension of the CMU. After the mixtures have stood undisturbed for several weeks, the CMU forms a soft, fluffy and bulky lower layer which does not harden in the water. Stirring or shaking for a few moments re-establishes the suspension.

Two methods have been developed to accomplish this purpose. The first is a simple and clean process which employs a water-soluble white powder containing a new organic compound. About $1\frac{3}{4}$ grams (1/17 ounce) will process one gallon of a mixture of CMU and water, regardless of how

much or how little CMU is to be used. The organic conditioner is dissolved in the water, then the dry CMU is added, the mixture is shaken, and the job is done.

The second method, somewhat smeary (not developed at this Experiment Station), employs a low-grade fuel oil which, unlike most other petroleum oils, is actually heavier than water. Enough of this oil is added to the CMU to wet it. The mixture is then stirred into a slurry and water is added to any convenient volume. A short time after completing this mixture and putting it aside, the oil and CMU settle out. However, the CMU, being saturated with the oil, cannot form a hard cake and may be dispersed in the mixture again at any time by vigorous agitation.

DALAPON—OUTSTANDING GRASS KILLER

Dalapon, the sodium salt of 2,2-dichloropropionic acid, developed and patented by the Dow Chemical Company, is an outstanding grass killer and is readily soluble in water. When exposed to

the air, the compound absorbs moisture at a rapid rate and deterioration occurs. In water solution, it undergoes hydrolysis and breaks down into pyruvic acid, with the formation of chlorides. This



Figure 48. A planter's field in the Piihonua area at Hilo Sugar heavily infested with torpedo grass, *Panicum repens*, is shown at the left. Note the relatively light stand of cane and grass inside the field. The only treatment given this area was a pre-emergence application of 2,4-D. The area shown at the right is inside the field.

change takes place slowly at first, but the rate of decomposition is increased on standing and is further accelerated if the solution becomes warm. A high degree of acidity is developed by this hydrolysis, and as a result the solution becomes quite corrosive to common metals.

The herbicidal action of Dalapon on grasses is systemic. It may be absorbed by the grass blades or by the root systems. It is more practical and less costly, however, to apply a solution of Dalapon to growing grass blades. It is also desirable to add an effective wetting agent and to keep the concentration of the chemical low enough so that it

does not immediately burn or otherwise injure the absorptive ability of the blades.

A method has been developed in the laboratory of the Chemistry Department to prepare a concentrated water solution of Dalapon capable of remaining stable and effective when stored in steel or iron containers for a period of from two weeks to one month. This concentrate carries $3\frac{1}{2}$ pounds of 100 per cent Dalapon per gallon. It is non-corrosive, contains a built-in wetting agent, and carries other additives, including buffering agents and stabilizers. It may be diluted as required for field application by simply adding cold water.

COMPARISON OF DALAPON AND TCA FOR CONTROLLING GRASSES

The Agronomy Department, in making comparative studies with Dalapon and TCA for controlling grasses, has conducted tests with both chemicals, singly and in combination, on manienie, tall *Panicum*, torpedo grass, *Panicum repens*, rice grasses, crabgrass, yellow foxtail and kikuyu grass (Figures 48 and 49).

In all of the above tests, Dalapon proved more effective than TCA. The range of effective per-acre dosages varies from about one pound Dalapon to

from four to eight pounds TCA. Applying 10 pounds of Dalapon per acre has shown the same effectiveness as did 40 to 80 pounds of TCA per acre.

Combinations of the two chemicals have been highly effective on torpedo grass but have not proved valuable for other grasses.

Current tests with a relatively new chemical, amino triazole, indicate that it is quite effective in combination with Dalapon.

NEW PROCESS FOR PREPARING AMINE CONCENTRATE OF 2,4-D

A new, self-heating process for preparing a five-pound per gallon amine concentrate of 2,4-D has

been developed. In this process, the warmth generated by the reaction of 2,4-D acid with dietha-



Figure 49. Shown at the left is an area in the same field shown in Figure 48. The area on the right had been treated with six pounds of Dalapon per acre; the area on the left with 15 pounds of TCA per acre. This area had also been treated once with 2,4-D for pre-emergence. Note the dense stand of cane and the height of the stalks in comparison with the cane in Figure 48. The picture at the right was taken inside the area treated with six pounds of Dalapon per acre.

nolamine and water is utilized to liquefy and complete the formulation.

While diethanolamine costs about three cents a pound more than triethanolamine, less of it is

needed. There is a distinct saving in time and money over the steam treatment required to process triethanolamine and 2,4-D acid into such a concentrate.

SILVEX APPEARS PROMISING IN FIELD TESTS

Silvex—2,4,5-T propionate—related to Dalapon and 2,4,5-T¹—has been proved valuable as a pre-emergence herbicide in field plot studies made by the Agronomy Department, Island Representatives, and plantation agriculturists. The chemical is obtained both in the basic acid form and also as the low-volatile ester. The Department of Chemistry has shown that these two raw materials yield concentrates of the sodium salt, the amine, and both oil- and water-miscible ester formulations. The raw materials may be purchased from any one of three mainland chemical manufacturers.

A recent development, in addition to those described above, is a four-pound per gallon concentrate, as expressed by the acid equivalent of Silvex in a water-soluble concentrate which is easily prepared.

Considerable data from past and current tests with Silvex have been accumulated by the Agronomy Department. The general conclusions are as follows:

1. Silvex is less volatile than 2,4-D or 2,4,5-T.
2. The three forms of Silvex—sodium salt, amine salt, and the esters—are less effective in pre-emergence control than 2,4-D and 2,4,5-T.
3. In most tests, Silvex gave longer periods of control on a pound-for-pound basis than 2,4-D and 2,4,5-T. In tests comparing Silvex and CMU at equal dosages, Silvex has generally given shorter periods of control, but has occasionally almost equalled CMU's performance.

NOTE: Silvex has not thus far been approved for registration by the USDA for use in sugar cane fields.

2,4,5-T ETHANOL FOR PRE-EMERGENCE

This compound is a light gray, lumpy, and oily substance. It may be dissolved in hot aromatic herbicide oil at the rate of two pounds of the

chemical per gallon. Adding about five per cent of a suitable emulsifier makes it miscible with water. Screening tests made at this Experiment

Station with this compound indicated that it would rank with 2,4,5-T on a pound-for-pound basis in pre-emergence work. The cane plant was proved to be unusually tolerant to it. However, reports

describing field tests of this chemical place it, apparently, in a second or even third category in relation to some of the outstanding pre-emergence compounds now being used in plantation practice.

EFFECT OF CMU AND DCMU ON SUGAR CANE

A study was made to determine the comparative effect of CMU and DCMU on sugar cane when exact amounts of each were mixed in a given volume of soil in which seed pieces of sugar cane were germinated and the plants grown. The levels of each chemical applied were 2.5, 5.0, 10.0, 20.0 and 30.0 parts per million of air-dry soil, in comparison with untreated soil. The respective amounts were 3.5, 7.0, 14.0, 28.0 and 42.0 pounds per acre mixed in the surface six inches.

Data from this test, when applied to the low

humic latosol soil group, are presented in Figures 50 and 51. The effect of CMU was appreciably greater than that of DCMU. Similar results were obtained in tests with alluvial and gray hydromorphic soils. DCMU's lesser effect on the cane plant is undoubtedly due to its lower solubility. DCMU has a solubility of 40 ppm in water as compared to a solubility of 240 ppm for CMU.

Figure 52 shows the rates at which CMU and DCMU disappear from the three soil groups. It will be noted here that DCMU is the slower. Since

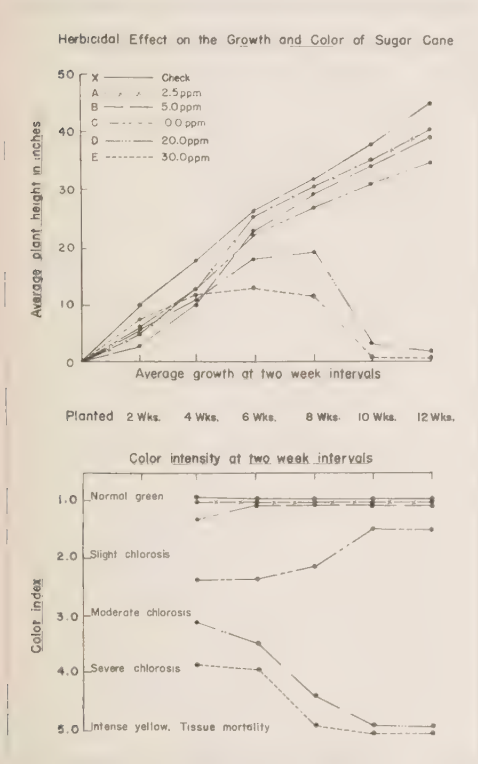


Figure 50. The effect of CMU on sugar cane growing on low humic latosol (N-5) soil is as follows:

CMU	Level of Application in Six Inches of Soil					
Parts per million.....	Check	2.5	5.0	10.0	20.0	30.0
Pounds per acre.....	0.0	3.5	7.0	14.0	28.0	42.0
Av. Plant Height (inches).....	49.2	42.8	41.3	33.9	0.0	0.0
Av. CMU Index (Plant Color)....	1.0	1.0	1.0	1.5	5.0	5.0
CMU Index (Root).....	1.0	1.0	2.0	4.0	5.0	5.0
Root Volume (cc).....	125	100	60	45	2	2

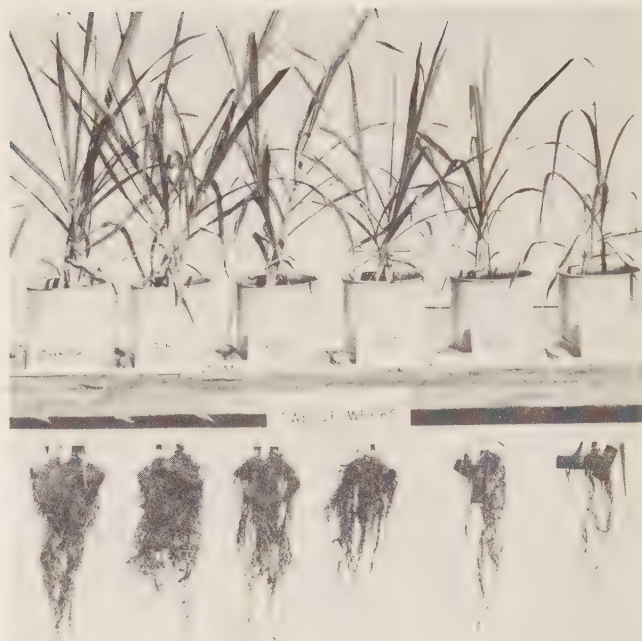
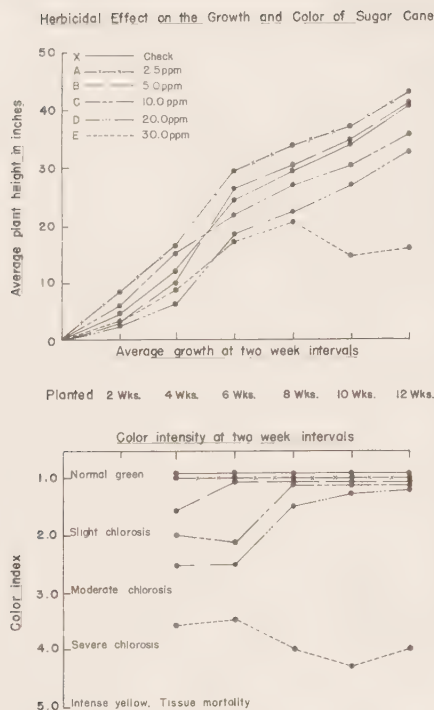


Figure 51. The effect of DCMU on sugar cane growing in low humic latosol (N-5) soil is as follows:

DCMU		Level of Application in Six Inches of Soil					
Parts per million.....	Check	2.5	5.0	10.0	20.0	30.0	
Pounds per acre.....	0.0	3.5	7.0	14.0	28.0	42.0	
Av. Plant Height (inches).....	49.2	42.9	42.3	30.3	28.5	17.8	
Av. DCMU Index (Plant Color)...	1.0	1.0	1.0	1.0	1.0	4.0	
DCMU Index (Root).....	1.0	1.0	1.5	3.0	4.0	4.5	
Root Vol. (cc).....	125	135	60	40	18	5	

the disappearance of these compounds from the soil is believed to be largely due to microbiological action and leaching of the water-soluble fraction, it appears that DCMU is decomposed and leached at a slower rate than CMU. Comparative data on the two chemicals have shown a slight to appreciable increase in number of days' weed control from DCMU over CMU.

Tests of the effects of CMU on sugar cane yield have been harvested on five plantations: Grove Farm, Kekaha, Lihue, Oahu Sugar and Olaa. Of

these tests, only one in a field at Kekaha has shown significant reduction in yields of sugar where up to 20 pounds of CMU were applied per crop. In the one treatment of significant yield reduction, 10 pounds per acre of CMU were applied initially, with a repeat treatment of 10 pounds per acre. Based on these tests, sugar cane shows considerable tolerance to CMU. Damage to cane is unlikely when CMU or DCMU are properly applied. Cases of damage from CMU have been traced to over-application.

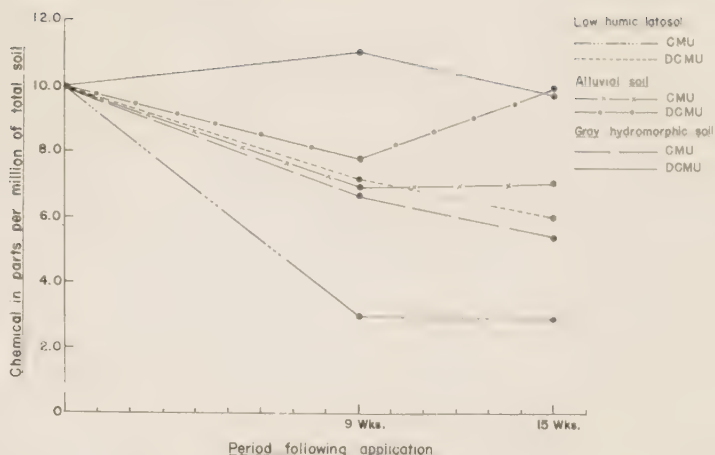
COMPARATIVE EFFECTIVENESS OF THE SUBSTITUTED UREAS

Studies have been made of the comparative number of days' control given by each of the substituted ureas, CMU and DCMU.

Conclusions from these and other data are:

1. The longest and the most consistent periods of control have been obtained by these two herbicides on the humic and hydrol humic latosol soils.

Figure 52. Disappearance of CMU and DCMU from three sugar plantation soils.



2. With few exceptions, DCMU has given control, pound for pound, equal to or appreciably longer than that given by CMU.

3. In only a few cases was longer weed control obtained when the substituted ureas were applied in CADE instead of in water.

VOLATILITY STUDIES WITH HERBICIDES

The volatile effects of several herbicides on tomato plants have recently been studied cooperatively by the Department of Agronomy and the Division of Marketing of the Territorial Board of Agriculture and Forestry. A full illustrated report will be issued (Figure 53).

The herbicides to be tested were dissolved or emulsified at levels of five pounds active ingredient in 50 gallons of water (approximately 12,000 parts per million). Petri dishes, each holding 25 milliliters of one of the solutions or emulsions, were placed on top of the soil in pots holding

tomato plants of the Pritchard variety. These were then enclosed in cellophane bags and exposed to the chemicals over a period of 14 days. The results are given below.

The volatility index standards were as follows:

Index	Condition
1	No apparent effect
2	Light curvature
3	Moderate curvature
4	Severe curvature
5	Plants dead or dying

The herbicides which caused severe symptoms in 14 days were the PGBE esters of 2,4-D and 2,4,5-T and the iso-octyl ester of Silvex.

Herbicide tested	Volatility index (average of 4 plants)			
	20 hours	44 hours	6 days	14 days
PGBE ester of 2,4-D	3.0	4.0	4.5	5.0
BE ester of 2,4-D	1.5	2.0	3.0	3.5
Triethylamine salt of 2,4-D	1.5	1.5	2.0	2.5
Triethanolamine salt of 2,4-D	1.0	1.0	1.0	2.0
Sodium salt of 2,4-D	1.0	1.0	1.5	1.5
PGBE ester of 2,4,5-T	3.0	4.0	4.5	5.0
BE ester of 2,4,5-T	1.0	1.5	1.5	1.5*
BEP ester of 2,4,5-T	1.0	1.0	1.0**	1.0**
Triethylamine salt of 2,4,5-T	1.0	1.0	1.0	1.5
PGBE ester of Silvex	2.5	3.0	3.5	3.5*
Iso-octyl ester of Silvex	2.5	3.0	3.75	4.0
Triethanolamine salt of Silvex	1.0	1.0	1.0	1.5
Sodium salt of Silvex	1.0	1.0	1.0	1.0
6831	1.5	1.5	1.5	1.5
Amino triazole	1.0	1.0	1.0	1.0
Check	1.0	1.0	1.0	1.0

* Two plants affected by insects. ** Average of two plants.



Figure 53. In volatility studies with 2,4-D, the tomato plant used as check and shown at top left was not treated in any way. The plant, at top right, shows the effect of isopropyl ester forms at 18 days. Plant at lower left shows the effect of PGBE ester forms at 18 days. Note the comparatively lesser damage from the heavy ester as compared with the isopropyl ester. The plant, lower right, shows only slight volatile effects recorded from the triethanolamine salt. (See table of herbicides tested for effects of other herbicide forms.)

EFFECT OF 2,4-D, 2,4,5-T AND SILVEX ON MACADAMIA NUT TREES

Growers of macadamia nut trees have stated that 2,4-D and 2,4,5-T have drifted from sugar cane fields and have caused damage to macadamia trees.

An experiment was organized early this year in cooperation with Keeau Orchard on Hawaii and the Board of Agriculture and Forestry, to obtain information on the effect on macadamia trees of different amounts of 2,4-D, 2,4,5-T and Silvex.

To date, the evidence gathered shows that:

1. Terminal growth may be stopped when concentrated droplets strike new flushing growth.
2. Varied leaf symptoms, from dead spots to distortions and chlorotic venation, may result from concentrated droplets on leaves.
3. Nut set is apparently affected when 2,4-D comes in contact with young racemes that are in the flowering-to-young-nut stage.

CHEMICAL CONTROL OF NOHU

The plant Nohu *Tribulus cistoides*, normally a pest of beach areas, has proved to have potentialities of spreading into lands operated by several plantations for ranching or for diversified crops.

Tests with several chemicals have shown that 2,4-D is the most effective in controlling this species. Two treatments of five pounds per acre have been satisfactory.

Figure 54. The principle of liquid injection against an air pressure head, which is also used in other pressure knapsacks, has been incorporated in this unit developed cooperatively with the Sasaki Welding Shop. With parallel piping, both liquid and air are carried in all three tanks.



BIO-ASSAY METHOD FOR 2,4-D AND RELATED HERBICIDES

A method of bio-assay, using germinating lettuce seed for determining quantitative amounts of 2,4-D and related compounds in unknown solu-

tions, has been worked out by the Agronomy Department in cooperation with the Board of Agriculture and Forestry.

FULLY FABRICATED THREE-TANK PRESSURE KNAPSACK

During the year, a fully fabricated three-tank pressure knapsack was developed in cooperation with the Sasaki Welding Shop in Honolulu (Figure

54). This unit was developed to take the place of units formerly assembled from surplus oxygen tanks, which are no longer obtainable.

HSPA INHIBITOR OF CORROSION EFFECTIVE AND POPULAR

The development of the HSPA Inhibitor of Corrosion by the Department of Chemistry has been described in detail in previous reports. It is a source of gratification to announce that the U. S. Patent Office has granted a patent on this development.

This compound has been used by members of the Association for several years. It has proved satisfactory in controlling corrosion of metal containers, equipment, etc. In some cases, it stabilizes the solutions in which it is being used. It has been

used extensively in concentrates of Sodium TCA and in concentrated fertilizer solutions such as muriate of potash, and is being used on a rather large scale as a protective addition to very dilute solutions of PMA in the treatment of cane seed pieces prior to planting. It has also been found very economical and effective for use in water-cooling systems, such as that of the automobile engine. It controls the corrosive action of many herbicide and fertilizer solutions. Other uses for this inhibitor are being found from time to time.

TESTS WITH THE "AEROQUIP" PRESSURE INJECTOR

An "Aeroquip" pressure injector to be used in filling pressurized knapsacks has been developed by the De Rocher Company in Honolulu.

Observations and experiments have shown that this injector is superior to any equipment of this type previously used.

LINED TANKS FOR CORROSION CONTROL

A Koroseal-lined tank and lining material were obtained from the Haneberg Company of Honolulu to be tested with herbicides and fertilizers. The Koroseal lining material was tested in aromatic oil, alone and with PCP, and with diesel oil. It was also tested with TCA and fertilizer solutions. None of the materials used produced any deteriorating effect on the Koroseal.

The lined tank has been in test with concen-

trated ammonium sulphate and muriate of potash since early May. No corrosion has developed to date.

Observations have been made on several stainless steel fertilizer hoppers in use on plantations for muriate of potash. Thus far, the types 302 and 316 stainless steel are the only ones that have been found satisfactory in resisting corrosion by muriate of potash.

HOSES TESTED FOR RESISTANCE TO AROMATIC OIL AND ABRASION

Twenty-one different hoses, sold in Honolulu for handling herbicides and fertilizer solutions, were tested for their tolerance to aromatic oil, alone and with PCP, to diesel oil, to TCA solution, and

to fertilizer solutions, as well as to abrasion.

The data showed considerable variability in the tolerance of the hoses to both chemicals and abrasion.

TRAINING OF PERSONNEL



Figure 55. Assistants-in-Training for Agriculture.
O. R. Moe, W. P. Shafer, M. Uehara, J. A. Sasan
and J. H. Hewets.on

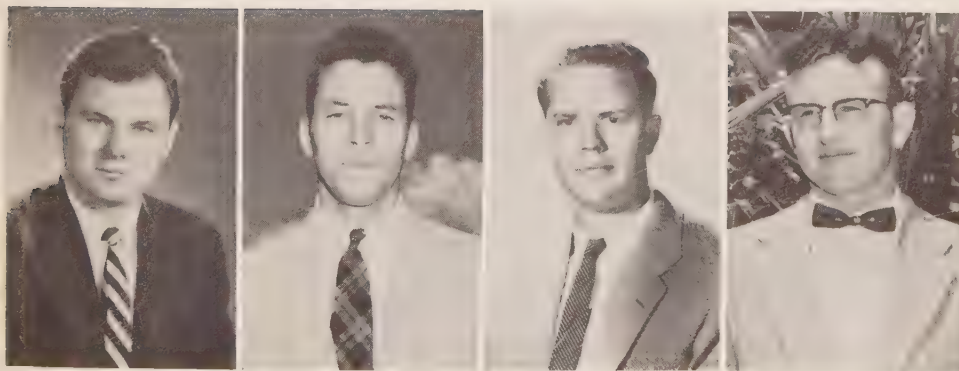


Figure 56. Assistants-in-Training for Sugar Technology. Z. M. Freilands,
G. F. B. Appel, R. E. Mott-Smith, E. D. Lyon.



Figure 57. Plantation Trainees for Agriculture. Left to right: G. Texeira, J. L. Cassel, A. E. Meyer, A. F. Winsley, R. Anzai, R. C. Stewart, Y. Morita, M. Ganeko, J. Regala, Jr., T. T. Toyama, W. Y. Koike.



Figure 58. Plantation Trainees for Sugar Technology. Left to right: K. Kobayashi, S. Nakaima, F. Ledesma, Jr., K. Miyagi, T. Moniz, S. R. Ito, W. L. Vredenburg, K. Akiyama, R. F. Duncan, M. Hironaka, D. M. Severn, K. Sumida, E. Sakumoto. Inset: D. Kinney, B. T. Townsley.

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September 30, 1955

